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VOL. 50 JULY, 1943 No. 1

THE EFFECT OF HEPARINIZATION ON EXPERIMENTAL POST-IRRADIATION TISSUE CHANGES IN THE LUNG

A PRELIMINARY STUDY*†

By FLOYD BOYS, M.D.
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and
IVOR DAVID HARRIS, M.D.
DETROIT, MICHIGAN

THE development of the use of heparin as an anticoagulant in the blood stream is recorded in a growing literature. The effect of heparin on fundamental aspects of the inflammatory process has been dealt with in several of these studies, but it has not received a great deal of attention. Several studies have been reported pertaining to the effect of heparin on the inflammatory process in the blood stream proper, such as thrombus formation.[1,21,22,23,27,28] With the exception, however, of a very few papers dealing with capillary permeability and phagocytosis,[11,26,27] research on the effect of heparin on the inflammatory process in extravascular tissues has been limited to studies on inflammation in the large serous cavities.[14,15,16,20,32] It is logical to suppose that heparin must affect inflammation. Only after a serous exudate coagulates in the form of fibrin does the development of new tissue begin, i.e., the onset of organization.[2a,3,14] If heparin will inhibit the formation of fibrin in fluid exudate, the diminution of fibrosis might be expected. In the large serous cavities, this phenomenon has been studied most extensively by Boys and Lehman[14,15,16] in a series of animal experiments dealing with the prevention of the re-formation of divided peritoneal adhesions. Their evidence clearly indicates that heparin has a striking action in limiting fibrosis when it is brought locally into contact with the inflammatory exudate.

The present study is an attempt to extend the application of this principle to the inflammatory process in the interstitial tissues of parenchymatous organs by observing in the rabbit the effect of heparinization on irradiation fibrosis of the lung. The pathological picture in the lungs of patients following irradiation has been described by many workers,[5,7,8,12,19,22,30,31] but

* From the Department of Surgery and Gynecology (Dr. Boys) and the Department of Radiology (Dr. Harris), University of Virginia School of Medicine, Charlottesville, Virginia. Presented at the Forty-third Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 15–18, 1942.
† Aided by a grant from the John and Mary R. Markle Foundation.

only a few studies can be found pertaining to these changes in animals.[4,6,29,33] Apparently no other study on irradiation pulmonary fibrosis has been made from the present approach.

METHODS

Young adult white Belgian rabbits of both sexes were used, the average weight being about 2.5 kilograms. They were fed on a standard laboratory diet.

All animals were treated with roentgen radiation using the following physical factors: 200 kv., 25 ma., 50 cm. skin-target distance, and 0.5 mm. copper and 1.0 mm. aluminum filtration. Each dose was calculated as 700 roentgens in the air at the skin level. No depth dosage was estimated as the interest was only in administering an effective dose. A treatment was given to the entire thorax on alternate days until six or seven treatments had been completed, the number varying with the general condition and weight of the animal. The period of roentgen irradiation was fourteen days and each animal received a total of either 4,200 or 4,900 roentgens.

The animals were divided into two series distinguished by the length of observation. Each series was separated into two groups —control and experimental. The former received irradiation alone, and the latter was heparinized with liquaemin* in conjunction with irradiation. Heparin was given subcutaneously in an attempt to keep the blood coagulation time, as determined by the Pohle and Taylor method,[24] above twenty minutes. Certain minor differences in the method of heparin administration in the two series will be noted.

Series I (Short Term Experiments). This series, consisting of observations on 11 control and 12 heparin animals, was terminated at the end of the fourteen day period of roentgen irradiation in order to study the effect of heparinization early in the inflammatory process. The experimental animals of this group received 5 milligrams of heparin (500 anticoagulant units) at twelve hour intervals during the fourteen day period of roentgen treatment.

Series II (Long Term Experiments). This series, numbering observations on 21 control and 16 experimental animals, was devised to permit study of the effect of heparinization upon the late phases of the inflammatory process (pleural adhesion formation and pulmonary fibrosis). The experimental animals received 5 milligrams of heparin subcutaneously at six hour intervals for six weeks from the beginning of irradiation in an attempt to cover a major portion of the destructive phase of irradiation.[9]

RESULTS

Series I.

Gross Pathologic Findings. In the control animals (Fig. 2), the pleura was injected, and slight amounts of free fluid were occasionally observed in the pleural gutters. No adhesions occurred in any of these animals. The lungs presented externally large areas of brownish-red tissue representing collapsed alveoli or alveoli containing exudate with some areas of normal pale salmon-colored parenchyma. These lungs were one and a half times their normal size, and the average weight was twice normal. As judged by color, crepitus, and cut surface inspection, the control lungs presented reduced aeration. There was a moderate amount of bloody exudate on the cut surfaces.

In the experimental animals (Fig. 3), the pleural changes were the same as those in the controls. The lungs also showed grossly similar changes but they were generally less severe. The lungs of the experimental animals were somewhat larger than normal, but smaller than those in the controls and their weights averaged the same. The lungs were better aerated as judged by definitely more normal pinkish-yellow parenchyma, more crepitus, and less bloody exudate on cut surfaces.

* This material was supplied through the courtesy of Hoffman-LaRoche, Inc., of Nutley, New Jersey.

Fig. 1. (*upper left*). Lungs of a normal rabbit for comparison with Figures 2, 3, 6, and 7.

Fig. 2. (*upper center*). Lungs of a control rabbit following 4,900 roentgens, given over fourteen days. Animal killed on the fourteenth day.

Fig. 3. (*upper right*). Lungs of an experimental rabbit following 4,900 roentgens, given over fourteen days, combined with continuous heparinization. Animal killed on the fourteenth day.

Fig. 6. (*lower left*). Lung, *in situ*, of a control rabbit sixteen weeks following the initiation of roentgen irradiation. This animal received 4,900 roentgens given over fourteen days. Note pleural adhesions and discoloration of lung.

Fig. 7. (*lower right*). Lung, *in situ*, of an experimental rabbit twelve weeks following the initiation of roentgen irradiation, to a total of 4,900 roentgens given over fourteen days. This animal also was continuously heparinized over a period of six weeks. Note the practically normal color of the lung and the complete absence of pleural adhesions.

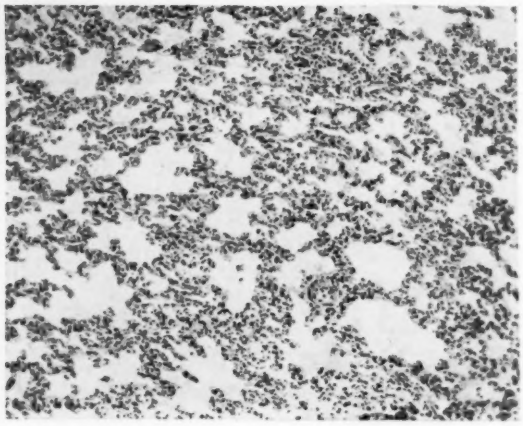

FIG. 4. Photomicrograph from a typical area in the involved portion of the lung of a control rabbit, corresponding to lungs shown in Figure 2.

*Microscopic Pathologic Findings.** In the control animals, the pleura was edematous and hyperemic. The parenchyma (Fig. 4) showed in large and small irregular areas active hyperemia with polymorphonuclear infiltration. There was reduced aeration most of which was due to focal atelectasis and to a less extent to non-fibrinous exudate. The air sacs contained some desquamated cells and a few red blood cells. Evidence of parenchymal fibrosis was absent except in one rabbit which presented a few focal areas of beginning organization in association with consolidation. The bronchi showed hyperemia of the walls, and the lumina usually contained desquamated cells. The small arteries exhibited swelling of the intima, and some thickening of the media in several instances. Thrombi were occasionally seen.

In the experimental animals, the same abnormalities were seen in the pleura, bronchi, and small arteries as were observed in those structures in control animals. The parenchymal changes (Fig. 5) were also similar, but were less marked. There was generally greater aeration and no areas of consolidation or fibrosis were discernible. Atelectatic areas were minimal.

* The microscopic sections in both series were reviewed by Dr. W. Ansell Derrick, Assistant Professor of Pathology, University of Virginia School of Medicine.

Incidental Observations. The control animals gained an average of about 24 grams in weight, whereas the experimental animals lost an average of 373 grams. The color and anatomical relationships of the pericardium and heart appeared normal.

Series II.

It was intended to permit the animals in this series to survive up to a period of about five months. Unfortunately, a large number of animals died at shorter intervals from various causes. In the control group, 14 of the 21 animals died spontaneously apparently from pulmonary damage. The average duration of life was twelve weeks in this group, with the longest survival twenty-one weeks. The remaining 7 animals were killed at about five months.

All of the 16 experimental animals died spontaneously, none surviving over thirteen weeks. The causes of death in the heparin animals were apparently a combination of lung damage and heparin effect as evidenced by small hemorrhages. In the animals surviving the longest period of time, the causes of death were not clear. The results recorded below in the experimental group are all from animals which survived longest.

Gross Pathologic Findings. In the controls (Fig. 6) several animals presented

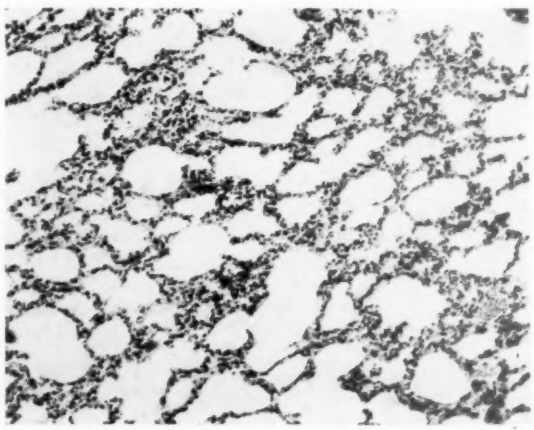

FIG. 5. Photomicrograph from a typical area in the involved portion of the lung of an experimental rabbit, corresponding to lungs shown in Figure 3.

pleural adhesions from lung to pericardium, lung to parietal pleura, and lung to diaphragm. Free or encapsulated pleural fluid was found in many of the control animals. The lung findings were markedly abnormal. On the average, these lungs were twice normal size, and weighed three times as much as normal. The aeration was greatly reduced as evidenced by extensive diffuse reddish-brown discoloration and by diminished crepitus. On section, it was apparent that considerable portions of the tissue were unaerated either from atelectasis or fibrosis.

In the heparin animals (Fig. 7), the gross findings were much less severe. There were no pleural adhesions, and no collections of free fluid in the pleural gutters. The lungs were smaller than those in the controls and in a few instances approached normal size. The average weight of the lungs was only twice normal. As judged by color, crepitus, and cut section the heparin lungs were better aerated than the controls.

Microscopic Pathologic Findings. In the control animals, there was a subacute pleuritis with thickening and some round cell and polymorphonuclear infiltration. The parenchyma (Fig. 8) showed patchy areas of pneumonia, round cell and polymorphonuclear infiltration, and atelectasis associated with fibrosis. Intervening lung tissue was edematous, with thickened alveolar walls, and desquamated cells and phagocytes in the alveoli. The bronchi evidenced degeneration and infection of their walls of a moderate degree and the lumina contained desquamated cells and other cellular elements. In a few rabbits, there was evidence of a purulent bronchitis with small bronchogenic abscesses in a number of areas. The small arteries showed obliterative endarteritis with swelling and degeneration of the intima, and thickening of the media.

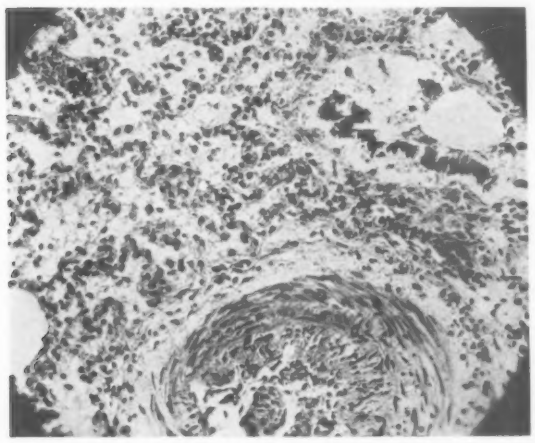

Fig. 8. Photomicrograph from a typical area in an involved portion of the lung shown in Figure 6.

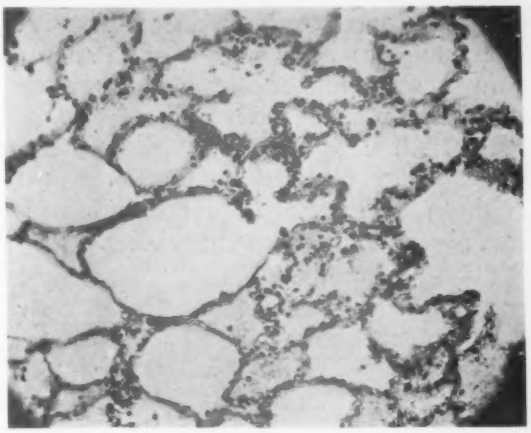

Fig. 9. Photomicrograph from a typical area in the involved portion of the lung shown in Figure 7.

In the experimental animals, the lung changes were less severe. The pleura was thickened with little or no cellular infiltration. The parenchyma (Fig. 9) presented much less edema, and the alveoli were better aerated. In some instances, aeration approached normal. There was no fibrin deposition and no consolidation or fibrosis except in one instance. Slight atelectasis was seen, and also some compensatory emphysema. The bronchial findings were similar to those seen in the lungs of the control animals, but were perhaps less severe. The small arteries presented changes similar to those in the control lungs.

Incidental Observations. As the animals in both groups approached death, or when they reached in longevity a period over fourteen weeks, they became progressively more listless, anorexic and dyspneic, and

their cage activity was reduced. The average change in body weight of the control animals was a loss of 9 grams, whereas that for the heparin animals was a loss of 398 grams. All control animals showed some direct fibrous attachment of the pericardium to the substernal tissues which was absent in the heparin rabbits.

DISCUSSION

These experiments seem to indicate that heparin has a definite effect on the inflammatory process in the lung parenchyma. The inflammation which follows roentgen irradiation damage to the lungs of rabbits is somewhat less extensive when heparin is administered than without heparin and the later changes (pulmonary fibrosis and pleural adhesion formation) are markedly diminished. This observation is consistent with the results reported by Lehman and Boys in studying the effect of heparin on the inflammatory process in the peritoneum.

The potentialities of the control of tissue fibrosis with heparin are barely indicated by this study. Since heparin is a dangerous drug, much more extensive work covering other types of inflammation is required before it will be possible to make practical use of the phenomenon so strongly suggested by the present results. Certainly, the clinical administration of heparin to protect the lungs during and after irradiation is not justifiable on the basis of the present work.

From a more fundamental point of view, the observations resulting from the present experiments suggest a new technique for the measurement of the effect of roentgen irradiation on various tissues, particularly in the field of malignant tumors. The estimation of the lethal effects of roentgen irradiation on cancer cells in experimental studies has been confused by the accompanying fibrosis which helps to produce a relative ischemia. It is still apparently not established in the minds of radiotherapists and pathologists whether the effect of roentgen irradiation in checking malignant growth is entirely a direct destruction of the cancer cell, or whether this destruction is much or little enhanced by the accompanying fibrosis. If fibrosis can be markedly diminished in the experimental animal with the use of heparin, there may be at hand a new biological method for measuring direct roentgen irradiation effect on cells in the living body.

CONCLUSION

The administration of heparin in the rabbit apparently diminishes the injury to the lungs caused by roentgen irradiation.

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DISCUSSION

Dr. L. R. Sante, St. Louis, Mo. I think that we are all convinced by this beautiful presentation of the effect of heparinization in limiting fibrosis. I feel sure that most of us as radiologists, however, have thought of heparin as a drug used by surgeons for the prevention of thrombosis. To most of us it was thought of as a drug with great potential possibilities which had not yet been fully developed because of its toxicity and the danger of secondary hemorrhages. In fact, many cases are present in the literature where the attendant hemorrhages have resulted in the abandonment of the use of the drug even in the treatment of thrombosis, but now it appears that with more refined methods, a purer, less toxic product has been developed, and that with greater experience in administration, the danger of secondary hemorrhage has been minimized. Recent publications of certain Swedish investigators indicate that their results, in hundreds of injections for the prevention of thrombosis, were without untoward toxic reaction.

It seems that heparin is widely distributed in the human body, especially in the liver, lungs and intestinal mucosa. It appears to be closely associated with mast cells and basophilic leukocytes, and Holmgren and Wilander have demonstrated direct correlation between the heparin content of tissues and the amount of mast cells contained therein. They are very abundant near capillaries which may account for the fluid state of the blood in the capillaries. Heparin is present also in the cornea, lens and iris, which probably accounts for the fact that hemorrhage into the eye generally does not clot. Perhaps its extremely high content in lung

tissues may account for the failure of blood to clot so readily in the pleural cavity.

As I understand it, heparin, activated by plasma, and thrombokinase are antagonistic, that is, one inhibits and the other promotes the conversion of prothrombin into thrombin, and excess of either counteracts the effect of the other, and this is the basis of the clinical use and the basis of its use here in this experiment. I must admit frankly that any possible use of the drug beyond that of an anticoagulant did not occur to me. However, Lehman and Boys, in a previous communication, showed that heparin could be used to prevent formation of fibrin in the production of peritoneal adhesions. They reasoned that the formation of the peritoneal adhesions is the final result of exudate on the peritoneal surface. This exudate, at first serous, becomes fibrinous and the fibrin in turn is organized by the connective tissue and blood vessel elements of the subserosa. The process of organization always takes place in the fibrin and cannot take place without fibrin. By the prevention of fibrin formation, therefore, organization which is the essential element of permanent pathology can also be prevented, and it is by this break in the continuity that this is attempted. It was reasoned that since heparin will prevent fibrin formation in the blood stream, it might also prevent its formation in an exudate such as peritoneal adhesions or such as post-irradiation fibrosis, and this was found to be true in the experimental animals. This is, as far as I could find, the first instance of its use in preventing organization of exudate.

Now in this paper we have another application of the use of heparin to a purely radiological problem, the prevention of post-irradiation fibrosis of the lung. On first thought, one would wonder how heparin could exert any influence under such conditions, but on more mature consideration it becomes evident that the process is essentially the prevention of fibrin formation. just as it is in the prevention of peritoneal adhesions. Without fibrin the remainder of the organization process cannot go on. Fortunately, extreme degrees of post-irradiation fibrosis of the lung are not the great concern that they used to be, thanks to the divided dose technique. It is very possible, however, that the relatively small dose of radiation may do material damage to the lung structure, even though it shows no discernible evidence in the roentgenogram. It may be that when pulmonary fibrosis is evident in the roentgenogram, it constitutes extreme damage. Perhaps by the judicious use of this drug, it may be possible to prevent such injury to the lung. Perhaps, as suggested by the authors, it may be possible that if the part played by the organization of fibrous tissue could be eliminated, the normal cell structure would be more resistant. That is another phase to think about.

Perhaps if the actual cure of cancer, or the regression of cancer cells, is the result, in part at least, or perhaps in great part, to the choking off of their growth by fibrous tissue formation, the actual good done would be in a certain sense modified. Possibly by some means an optimum formula of administration of the most effective dose at precisely the correct intervals might prevent material injury to the tissues in treatment of lung or esophageal cancer and yet not endanger the patient's life from uncontrolled hemorrhage from the malignant tumor. At any rate, it opens up an entirely new field of research which has far-reaching possibilities.

It seems to me that this was a most convincing experiment and one which should lead to far greater possibilities if it is carried on in the future.

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ROENTGEN DIAGNOSIS OF MALIGNANT NASOPHARYNGEAL TUMORS*

By W. GEORGE BELANGER, M.D., *and* CORNELIUS G. DYKE, M.D.†
NEW YORK, NEW YORK

I. INTRODUCTION

UNCOMMON though they are, malignant tumors of the nasopharynx have not been forgotten in the roentgenological literature of today. However, for the most part such articles have been confined to therapy, and the diagnostic side of the picture has been little discussed. Cutler, Buschke and Cantril,[1] in their book on cancer, mention the soft tissue changes that occur in the epipharynx and the osseous destruction of the base of the skull that results from the upward growth of these tumors. Rüedi and Zuppinger[7] describe their method of injecting a radiopaque substance into the nasopharynx, the diagnosis of tumor being made by the filling defect produced. We have had no experience with lipiodol studies of the epipharynx, but we are describing in this paper the roentgenological demonstration of the specific soft tissue and osseous changes produced by these tumors, and are particularly interested in stressing the diagnostic advantage of supplementing standard roentgenograms of the skull with stereoscopic roentgenograms in the basal position. We believe that without the latter a definite roentgen diagnosis of nasopharyngeal cancer can seldom be made. Jönsson[3] in 1934 published an article advocating these same points, and in his series of 19 cases, not all verified, described and illustrated many of the changes that occur. Mayer[5] has mentioned some of the specific changes produced in the base of the cranium by nasal tumors. However, both intracranial and extracranial tumors were included in his paper, and his conclusions thereupon differ from ours.

II. MATERIAL

The material used as a basis for this study consists of cases that have been seen within the past decade at the Neurological Institute and Presbyterian Hospital, New York.

A great many more cases were encountered during this period of time than are here included. However, all were discounted except those verified histopathologically, either by biopsy or necropsy, and in which stereoscopic roentgenograms of the skull were taken in the basal position, as well as roentgenograms in the conventional views. These latter, as used routinely at the Neurological Institute, consist of single anteroposterior and posteroanterior and stereoscopic right or left lateral roentgenograms.

The following is a list of the individual pathological types of tumor included in this study: (1) squamous cell epithelioma (both differentiated and undifferentiated types), 7; (2) lymphoepithelioma, 5; and (3) cylindroma, 2; thus making a total of 14 cases in all.

III. ROENTGEN DIAGNOSIS

A. General Considerations. The nasopharynx is that part of the pharynx which lies immediately posterior to the choanae of the nose and above the level of the soft palate. Tumors in this portion of the pharynx occurring on the posterior or lateral walls grow downward into the lumen of the nasopharynx and upward toward the base of the skull. Increase in their size brings about resultant changes in the adjacent soft tissue and bone, the latter occurring largely in the sphenoid bone which

* From the Department of Roentgenology, New York Neurological Institute, New York. Presented at the Forty-third Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 15–18, 1942.
† Dr. Dyke died on April 23, 1943.

FIG. 1. Marie B. Lateral roentgenogram showing a typical osteoblastic reaction of dorsum sellae, basi-occiput and body of sphenoid produced by naso-pharyngeal lymphoepithelioma.

forms the osseous roof of the nasopharynx. These changes consist of both osseous proliferation and destruction. Before discussing the above in detail it may be well to mention several other points of possible value that were considered as aids in diagnosis: (1) Generalized increased intracranial pressure, as indicated by atrophy of the posterior clinoid processes and dorsum of the sella turcica alone, was looked for and found positively present in only 1 case. Five of the cases showed atrophy of the posterior clinoids and dorsum sellae, but this was accompanied by destruction of the body and great wing of the sphenoid bone, indicating that the process was due to local and not generalized increased pressure. (2) The position of the pineal gland was studied and was found to be within normal limits as measured by Dyke[2] in all of the 6 cases in which it was visible. (3) Intratumoral calcification was not seen in a single case.

B. Osseous Changes. As already mentioned, the bony changes consisted of both proliferation and destruction. A review of Table 1 shows that only 2 cases exhibited proliferation of bone. In one it was mild in degree and combined with destruction, and in the other showed an osteoblastic or osteosclerotic reaction severe in both degree and extent (Fig. 1). These 2 proved to be exceptions to the rule, for the remaining cases showed no evidence of bone proliferation. All did, however, reveal destruction of one or more structures in the base of the skull, and it is with these destructive changes that we are primarily concerned, for herein lies the key to the roentgen diagnosis of these tumors.

Figure 2 shows a normal roentgenogram in the basal position with the structures labeled that must be inspected if the proper diagnosis is to be made. The three structures most frequently involved were: (1) the body of the sphenoid bone; (2) the basi-occiput, and (3) the medial margin of the great wing of the sphenoid bone. Figures 3 and 4 show these typical obvious changes, all three of which occurred in 8 of the 14

FIG. 2. Basal roentgenogram of normal skull. *1*, left ethmoidal sinus. *2*, posterior margin of vomer. *3*, left sphenoidal sinus. *4*, left lateral margin of body of sphenoid. *5*, medial margin of right great wing of sphenoid. *6*, foramen ovale. *7*, foramen spinosum. *8*, apex of petrous portion of left temporal bone. *9*, basi-occiput.

cases. Due to its midline position the body of the sphenoid was most extensively and frequently affected (13 of the 14 cases), although in the majority of cases the tumor and the resultant destructive changes were slightly to the right of the midline. The apex of the petrous portion of the temporal bone and the foramina ovale and spinosum were involved less frequently. Destruction of the vomer occurred definitely in only 2 cases. However, this is due to inability to visualize this bone well in the roentgenogram, since because of its position it must necessarily be affected more frequently than can be determined roentgenologically. This is also true of the pterygoid processes, destruction of which must occur at their junction with the body of the sphenoid bone, yet the destruction could not be definitely determined unless a special study, such as laminagraphy, was employed to specifically visualize them.

Fig. 3. Elizabeth R. Basal roentgenogram. Note destruction of right side of body of sphenoid, right side of basi-occiput, medial margin of right great wing of sphenoid extending laterally to include margin of foramen ovale, and apex of petrous portion of right temporal bone. Note also the presence of a soft tissue mass in right side of nasopharynx and right sphenoidal sinus.

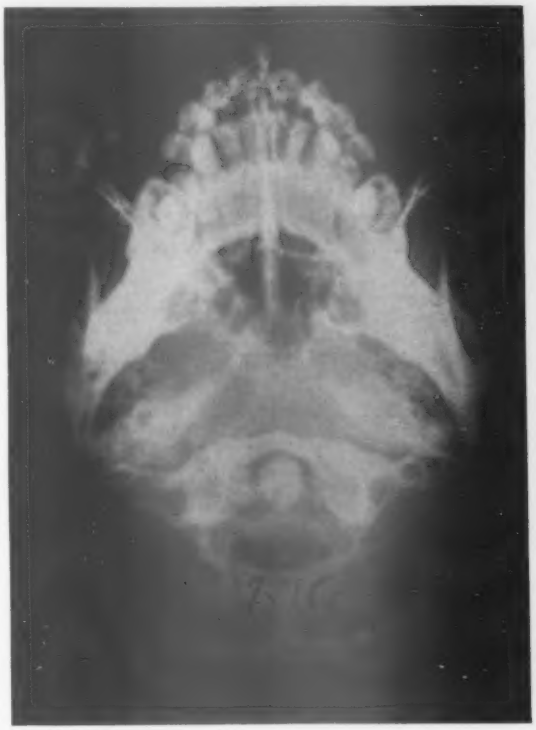

Fig. 4. Idell C. Basal roentgenogram showing typical destruction of right lateral margin of body of sphenoid, right lateral margin of basi-occiput, medial margin of right great wing of sphenoid extending laterally to include margin of foramen ovale, and apex of petrous portion of right temporal bone.

In addition to calling attention to the above structures subject to pressure erosion by the tumor, we wish to emphasize, as mentioned above, the importance of the basal roentgenographic study of the skull. Again consulting Table 1 it can be seen that the sella turcica showed destruction in only 5 of the 14 cases. This evidence was determined by examination of the lateral roentgenograms of the skull. Changes were also seen in the body of the sphenoid bone as viewed in the lateral projection, but again the destructive or proliferative bony changes were apparent in less than one-half of the cases, and even when seen were not definitely diagnostic of the pathological process. In view of this, and remembering the fact that the basi-occiput and great wing of the sphenoid bone are not well seen in the lateral studies, the necessity of taking

TABLE I

OSSEOUS CHANGES IN THE SKULL PRODUCED BY MALIGNANT TUMORS OF THE NASOPHARYNX

No. of Cases	Patient	Body of Sphenoid Bone	Basi-occiput	Medial Margin of Great Wing of Sphenoid Bone	Foramina Ovale and Spinosum	Apex of Petrous Portion of Temporal Bone	Posterior Part of Vomer	Sella Turcica
1	Regina G.	Destruction	Destruction	N	N	N	N	Destruction of posterior clinoid processes, dorsum and floor
2	Jacob W.	Destruction	N	Destruction of right	N	N	Destruction	N
3	Idell C.	Destruction of right side	Destruction of right side	Destruction of right	Destruction of right	Destruction of right	N	N
4	Kalil N.	Destruction	Destruction	Destruction of right	Destruction of right	N	N	N
5	Ralph D.	Mild osteosclerosis of right side	Mild osteosclerosis of right side	Destruction of right	Destruction of right	N	N	N
6	Marie B.	Marked osteosclerosis	Marked osteosclerosis	Osteosclerosis bilaterally	N	N	N	Marked osteosclerosis
7	John F.	Destruction	Destruction	Destruction bilaterally	Destruction of left	Destruction of left	Destruction questionable	Destruction of posterior clinoid processes, dorsum and floor
8	Max H.	N	Destruction	Destruction of right	N	N	Destruction questionable	N
9	Eliz. R.	Destruction of right side	Destruction of right side	Destruction of right	Destruction of right	Destruction of right	N	Destruction of dorsum
10	Molly M.	Destruction of left side	Destruction of left side	Destruction of left	N	Destruction of left	N	N
11	Henry S.	Destruction of right side	Destruction of right side	Destruction of right	Destruction of right	Destruction of right	N	N
12	David P.	Destruction	Destruction	Destruction of left	N	N	N	Destruction of posterior clinoid processes, dorsum and floor
13	Lila H.	Destruction questionable	N	N	N	N	N	N
14	Julia S.	Destruction	Destruction	Destruction bilaterally	N	Destruction bilaterally	Destruction	Destruction of posterior clinoid processes, dorsum and floor
14	Total cases involved	13	12	12	6	6	4	6

N = normal.

basal roentgenograms is evident. However, we must not lose sight of the fact that the evidence obtained from an examination of the lateral roentgenograms often proves to be a valuable clue and frequently stimulates the request for supplementary roentgenological studies which confirm the diagnosis.

Before proceeding further, the rapidity with which marked osseous destruction sometimes takes place is worthy of mention and the advisability of continued observa-

TABLE II

SOFT TISSUE CHANGES PRODUCED BY MALIGNANT TUMORS OF NASOPHARYNX
Includes comparative study of conventional lateral and basal views

No. of Cases	Patient	Lateral View		Basal View	Air Sinuses			
		Nasopharyngeal mass	Sphenoidal sinus mass	Nasopharyngeal and/or sphenoidal sinus mass	Sphenoid	Ethmoid	Maxillary	Frontal
1	Regina G.	Presence questionable	O	Present on left	Destruction and invasion by mass	Clouding bilaterally	N	N
2	Jacob W.	O	O	Present on right	Destruction and invasion by mass	Clouding on right	Cloudirg on right	N
3	Idell C.	O	O	Present on right	Cloudirg bilaterally; mass on right	N	N	N
4	Kalil N.	O	O	O	Clouding bilaterally	Cloudirg on right	Clouding on right	N
5	Ralph D.	O	Present	O	Clouding bilaterally	Clouding on right	N*	N
6	Marie B.	O	O	O	[Obscured by osteosclerosis]	Clouding bilaterally	N*	N
7	John F.	O	O	Present in midline	Destruction and invasion by mass	Clouding bilaterally	N*	N
8	Max H.	Presence questionable	Present	Present on right	Destruction and invasion by mass	Clouding on right	N*	N
9	Eliz. R.	O	O	Present on right	Clouding bilaterally	Clouding on right	N*	N
10	Molly M.	Present	O	Present on left	N	N	N	N
11	Henry S.	O	Present	Present on right	Destruction and invasion by mass	Clouding on right	Clouding on right	N
12	David P.	O	O	O	Destruction and clouding bilaterally	Clouding on left	Clouding on left	Clouding on left
13	Lila H.	O	O	O	Clouding bilaterally	N	N	N
14	Julia S.	Present	O	O	Destruction and clouding bilaterally	Clouding on left	N	N
14	Total cases involved	4	3	8	12	11	4	1

O = none.
N = normal.
* = cases which had chronic bilateral mucosal thickening.

tion of the patient is essential. This is particularly true if the roentgen examination reveals no abnormality. A persistence or exaggeration of symptoms definitely merits an early reëxamination. This is best illustrated by the case of Julia S. whose clinical findings were minimal and whose roentgenograms were normal (Fig. 5 and 6) on her first admission to the hospital, so that a definite diagnosis could not be made. Unfortunately, the patient was not seen until ten weeks later when she was readmitted to the hospital with a progression of symptoms. The reëxamination showed extensive

FIG. 5. Julia S. Lateral roentgenogram taken on first hospital admission shows no evidence of any abnormality. The sella turcica fails to show any destruction. There is no demonstrable soft tissue mass in either the nasopharynx or sphenoidal sinus.

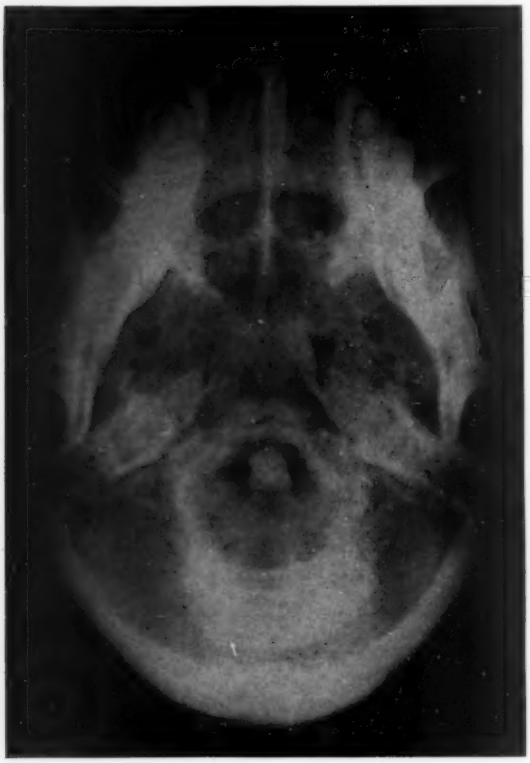

FIG. 6. Julia S. Same case as Figure 5. Basal roentgenogram taken on first hospital admission. Note no evidence of osseous destruction.

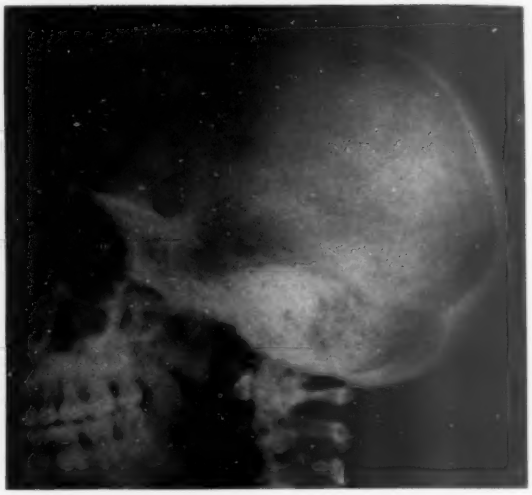

FIG. 7. Julia S. Same case as Figures 5 and 6. Lateral roentgenogram taken ten weeks later on second hospital admission. Note destruction of dorsum and floor of sella turcica and body of sphenoid. Only remnants remain of posterior clinoid processes. Note also the large soft tissue mass in nasopharynx.

osseous and soft tissue changes (Fig. 7, 8, and 9) although none had been present before.

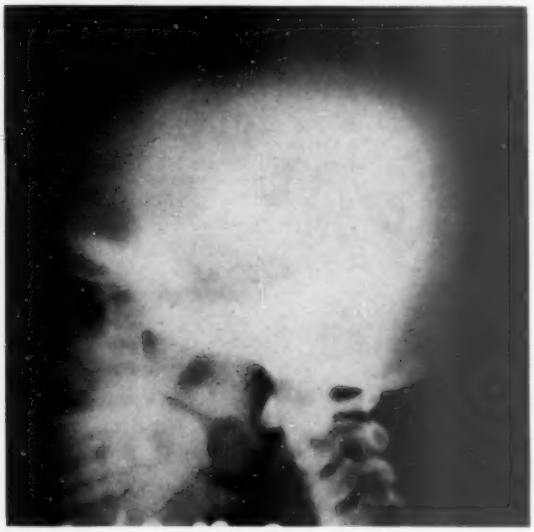

FIG. 8. Julia S. Same case as Figures 5, 6, and 7. Median sagittal laminagram taken ten weeks later on second hospital admission. Note extensive destruction of sella turcica and body of sphenoid. Note also the prominent soft tissue mass in the nasopharynx.

Mention should be made of one more point with regard to bone involvement. In none of these cases was there destruction involving the small wing of the sphenoid bone or margin of the superior orbital fissure. Roentgenograms of the optic foramina were not taken on any of the patients.

C. Soft Tissue Changes. Soft tissue changes are also of importance in the diagnosis of nasopharyngeal tumors. They consist essentially of changes in the paranasal sinuses, manifested by clouding or sinusitis, and the presence of a mass either in the nasopharynx, the sphenoidal sinus, or both. Table II shows that a mass was visualized in the lateral view in 6 of the 14 cases. This was not diagnostic in itself, but like the osseous changes detected in the lateral view gave an excellent clue to eventual interpretation of the pathological condition. Such was the case of Ralph D. (Fig. 10) in whom a mass was discovered in the sphenoidal sinus, and inspection of additional roentgenograms in the basal position revealed a malignant tumor of the nasopharynx. The presence of a mass was detected in 8 of the 14 cases upon examination of the basal roentgenograms. It was seen either as a sharply outlined shadow against the nasopharyngeal air column (Fig. 11) or a diffuse clouding in the region of the sphenoidal sinus. Jönsson[3] highly recommended particular attention to the contour of the nasopharyngeal air shadow in the basal roentgenograms. He further recommended that the roentgenograms be taken with the patient's tongue protruded or forward in the mouth so that this soft tissue structure would not obscure the outline of the air column.

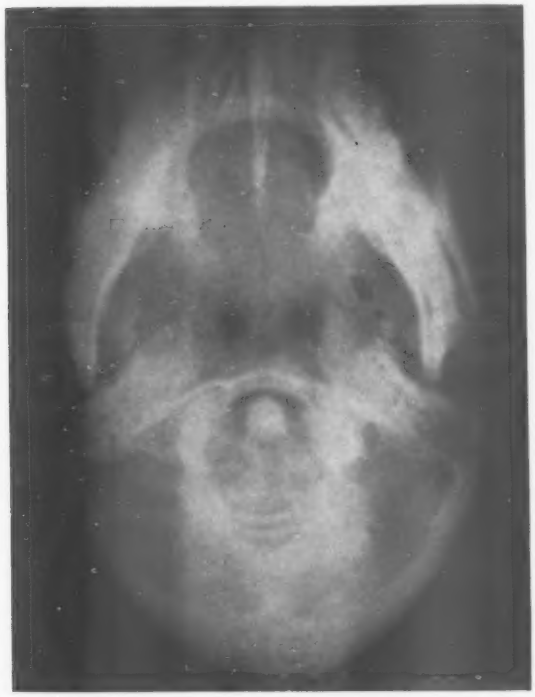

Fig. 9. Julia S. Same case as Figures 5, 6, 7 and 8. Basal roentgenogram taken ten weeks later on second hospital admission. Note extensive destruction of body of sphenoid, basi-occiput, medial margins of both great wings of sphenoid, posterior margin of vomer, and apices of petrous portions of both temporal bones. Destruction is so complete that the sagittal suture is extremely well visualized. Note also clouding of left ethmoidal sinus and presence of large soft tissue tumor in right side of nasopharynx.

Fig. 10. Ralph D. Lateral roentgenogram showing soft tissue mass plainly visible in sphenoidal sinus. There is no other abnormality evident.

Involvement of the paranasal sinuses is a common finding in association with these tumors. Excluding chronic mucosal thickening, not uncommonly encountered in the

FIG. 11. Max H. Basal roentgenogram before therapy showing destruction of body of sphenoid, basiocciput, and medial margin of right great wing of sphenoid. Note also presence of soft tissue mass in right side of nasopharynx, and clouding of right maxillary and ethmoidal sinuses.

maxillary antra, a fairly uniform clouding of one or more of the sinuses was observed in all but one of the cases. This effect is probably the result of a mechanical obstruction or an inflammatory process secondary to invasion by the tumor, except in the case of sphenoidal sinus clouding where it is due to the tumor itself. However, at the most, the presence of sinusal clouding in these tumor cases serves merely as an indication of possible additional trouble.

IV. DISCUSSION

While it is true that soft tissue changes occur early in the course of the growth of the tumor, nonetheless a definite diagnosis of nasopharyngeal cancer is seldom made roentgenologically until osseous changes have occurred, and thereupon it may be reasoned that the tumor is advanced in its growth. It may be argued from this that the value of a roentgenological diagnosis is lessened since it is based on changes that do not occur early. However, it must be stated that in not a few of the cases seen at the Neurological Institute the roentgen diagnosis of nasopharyngeal cancer represented the first time that such a diagnosis of the patient's disease had been seriously considered, and Jönsson[3] in 4 of his 33 cases also found this to be true. Criticism of the clinician is in no way intended; on the contrary, we are attempting to show that his chances of making an early diagnosis are equally if not even more difficult than the roentgenologist's, due to the paucity, or to the unlocalizable character when present, of the symptoms.

The importance of a roentgenological diagnosis is obvious when we consider the following observations by New[6] that the difficulty of recognizing the condition of nasopharyngeal cancer is shown by the fact that 185 operations, consisting of removal of tonsils, nasal septa and turbinates, polypi, and teeth, also myringotomies, mastoidectomies, and alcohol injections for neuralgia, had been performed for the relief of symptoms in 194 patients with malig-

FIG. 12. Max H. Same case as Figure 11. Basal roentgenogram taken during course of radiation therapy five months after that of Figure 11. Note remarkable regeneration of bone.

nant lesions of the nasopharynx previous to their admission to the Mayo Clinic. Thus roentgenological examination may well prevent many of these unfortunate surgical procedures by definitely establishing the diagnosis so that proper treatment may be instituted as early as possible. Martin[4] has discussed malignant tumors of the nasopharynx mainly from the therapeutic aspect and has called attention to the importance of the basal views of the skull.

We shall not discuss the treatment of these tumors in this paper. However, it is pertinent to mention that the treatment is, as Cutler, Buschke and Cantril[1] state, "exclusively radiologic." Figure 11 demonstrates the extensive osseous destruction that occurred prior to irradiation in the case of Max H., and Figure 12 shows the remarkable regeneration that resulted following radiation therapy. Such an instance, while certainly not the rule, is distinctly encouraging and serves as a fine example of what may result through a combination of proper roentgen diagnosis and radiation treatment of a malignant tumor of the nasopharynx.

V. SUMMARY AND CONCLUSIONS

1. Fourteen cases of malignant tumor of the nasopharynx represent the basis of this study. Only cases were considered which were (1) verified histopathologically and (2) on whom stereoscopic roentgenograms of the skull in the basal position had been taken, in addition to the conventional studies.

2. The diagnosis of these tumors was discussed from a purely roentgenological standpoint. The changes produced by the tumors were: (a) osseous, consisting largely of destruction of (1) the body of the sphenoidal bone, (2) the medial margin of the great wing of the sphenoid, and (3) the basi-occiput; (b) the soft tissues, consisting of (1) a mass in the sphenoidal sinus, (2) a mass in the nasopharynx, and (3) clouding of one or more of the paranasal sinuses.

3. The importance of a stereoscopic basal examination of the skull was emphasized, and a comparison made between the findings derived from examination of roentgenograms taken in both the lateral and basal positions. This showed that, while the lateral study can only offer clues to the nature of the pathological process, the basal study is usually necessary to definitely establish the diagnosis of malignant tumor of the nasopharynx.

4. Mention was made that the only successful treatment of such tumors is by radiation therapy.

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DISCUSSION

Dr. Fred J. Hodges, Ann Arbor, Mich. This short, terse and straightforward paper, dealing with an isolated subject in the field of skull diagnosis, certainly requires no lengthy discussion on my part. It is a great pleasure, however, to have the opportunity to add a word or two to what Belanger and Dyke have reported.

It certainly has been the experience of all of us that examination of the skull by means of any routine procedure which we may adopt leaves a good deal to be desired in the matter of completeness. It is not enough to make lateral and sagittal projections, because these alone

fail to bring into view a considerable part of the cranium and its contents. It is easy to imagine, having seen the greater part of the cranial vault, that no significant features have been obscured. However, in the particular group of patients which Belanger and Dyke have reported, it was quite necessary to examine the skull from an entirely different vantage point in order to recognize the clearly defined lesions lurking in the base of the skull. We like to call these "axial" projections because the beam follows the long axis of the skull and whether made with the vertex down or the mandible down the end-result is approximately the same.

When one studies axial skull roentgenograms carefully, particularly with the aid of stereoscopic vision, in order to examine areas of the skull floor otherwise invisible, it is interesting to realize suddenly that whole areas which should be intact are missing. Without such projections, nasopharyngeal tumors, even though they produce much destruction, are easily overlooked. These tumors have a great deal in common in their appearance as seen roentgenographically, and until one has had his first experience in this direction he does not realize the thrill of discovering the absence of familiar anatomical landmarks of the skull floor.

I was very much interested in the case which showed a soft tissue tumor lying within the sphenoid sinus. Certainly these must be rare because one sees a good many lesions of the destructive type without encountering one of this sort.

Dr. Belanger and Dr. Dyke are to be complimented for their extremely lucid presentation of a fairly limited subject within the range of skull diagnosis, but one which can be of intense importance as individual instances arise.

ENLARGEMENT OF THE ILEOCECAL VALVE*

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INTRODUCTION

THE ileocecal valve is composed of two margins, the lips, bounding the slit-like opening which connects the small with the large intestine. The slit is said to lie on the posteromedial aspect of the junction of the cecum and ascending colon and runs transversely to the long axis of the large intestine (Fig. 1). By rotation of the patient under the roentgenoscope, however, one gets the impression that the ileocecal junction frequently lies on the anterior aspect of the medial side of the cecum. On their adjacent aspects the lips are formed of muscle and mucosa from the ileum and on the side away from the opening they are formed of muscle and mucosa from the colon. They

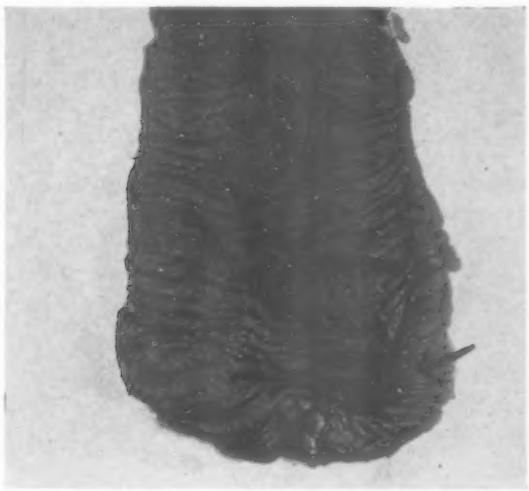

FIG. 1. The ileocecal valve on the posterior wall of the cecum which has been opened through the anterior wall. The slit-like opening runs transversely.

protrude slightly into the lumen of the large intestine. The lower lip is usually a little longer than the upper, according to the anatomical textbooks, but the upper usually overhangs the lower in the distended dried specimens. At the junction of the upper and lower lips the elevation of the wall is carried partway around the inner surface, forming the frenum. In the

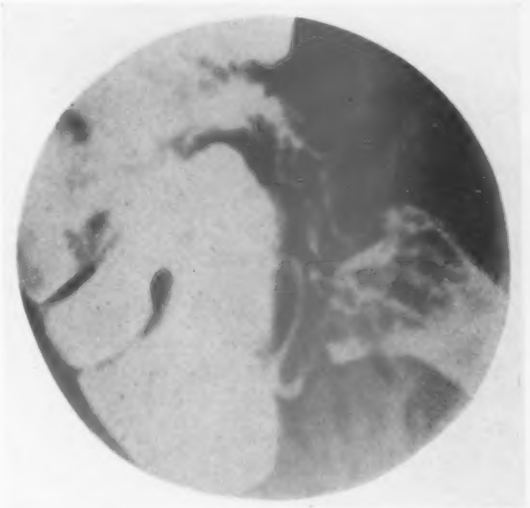

FIG. 2. A presumably normal ileocecal valve under moderate pressure. Many do not show as much evidence of the lips as this.

fresh normal specimen the margins of the opening are elevated very little and feel no different from the rest of the cecal wall.

The valve is rarely large enough to produce a recognizable indentation in the shadow of the barium-filled cecum. It can sometimes be demonstrated on pressure films (Fig. 2). Two cases were encountered in which the lips of the valve were enlarged. In one of them, the possibility of serious disease was mentioned. In the other, the enlargement was associated with regional enteritis.

Cancer may arise on or near the ileocecal valve and was mentioned in the differential diagnosis of the first case.

REPORT OF CASES

CASE 1 (Unit No. 559652). A female, aged sixty-two, for a short period two years before admission had nausea without vomiting for

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which no cause could be found. She was then symptom free until about a year before admission when nausea and vomiting began, most marked in the morning and not associated with pain. She was accustomed to drink as much as a bottle of sherry a day. On admission, a barium enema and barium given by mouth both disclosed a filling defect around the ileocecal junction (Fig. 3, *A* and *B*) which was interpreted as a mass of some kind, the nature of which could not be determined. It was thought most likely that the mass was a small intussusception, probably based on a small polypoid tumor although such a tumor could not be demonstrated. The report mentioned that a cancer arising on the ileocecal valve might conceivably give the same appearance.

The patient was discharged and in two weeks was readmitted for operation. In the interval she was symptom free, eating everything. The liver was enlarged. Slight tenderness in the right lower quadrant was found but no mass was palpable.

At operation, hypertrophy of the lips of the ileocecal valve was found with edematous mucosa covering them, causing a bulging into the cecum. The terminal ileum was edematous. Numerous peritoneal adhesions were present. A short circuiting side-to-side anastomosis of ileum to ascending colon was done. No evidence of a polyp of the ileum was found. Two weeks after the operation the vomiting recurred and was attributed to alcohol. Some months later she was readmitted for treatment of alcoholism.

CASE II (Unit No. 444581). A male, aged twenty-nine, physician, had vague cramping pain in the right lower quadrant for nine days with some localized tenderness in this region. Ten years previously he had an appendicectomy. His temperature was 99.4° F. for four days and then became normal. A barium enema disclosed a rounded area of diminished density in the cecum which was reproduced by a double contrast enema the following day (Fig. 4, *A* and *B*). An area of diminished density around the ileocecal valve was present on the roentgenograms. Not enough barium escaped into the terminal ileum to show it satisfactorily, but its mucosal folds appeared exaggerated. The shadow in the cecum was thought to be a polyp. The symptoms were relieved by a low residue diet. Unfortunately a small intestine study was not done. He was operated upon immediately and marked thickening of the terminal ileum for a distance of 8 cm. with large mesenteric lymph nodes was found. The cecum and terminal ileum were adherent to the posterior abdominal wall. The cecum near the ileocecal junction felt thickened to the surgeon. Ileocolectomy was done. The pathologic examination

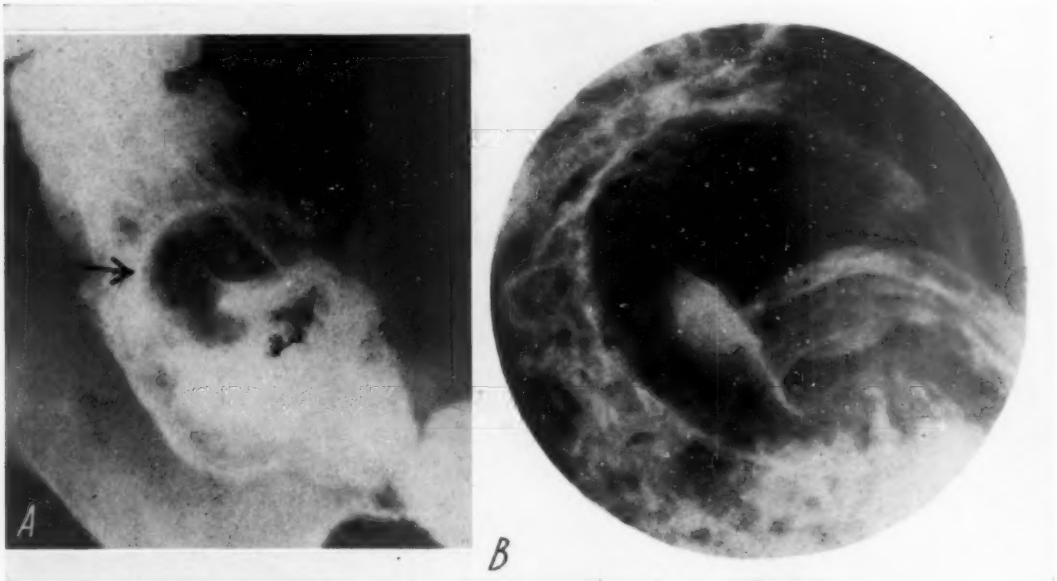

FIG. 3. Case I. Hypertrophy and edema of the ileocecal valve. *A*, roentgenogram taken without pressure, after the ingestion of barium, shows a large defect about the ileocecal junction, interpreted as suggesting slight intussusception. *B*, roentgenogram taken with pressure shows the defect about the ileocecal valve with the terminal ileum passing into its center. This is reproduced somewhat larger than *A*.

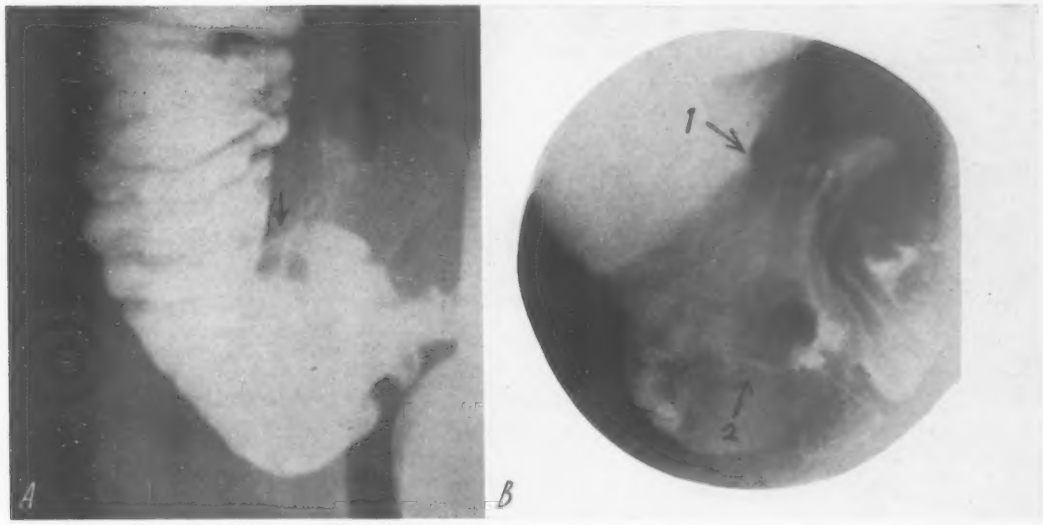

Fig. 4. Case II. Edema of the ileocecal valve with regional enteritis of the terminal ileum. *A*, the cecum is filled by a barium enema with a little barium escaping into the terminal ileum. The diminished density about the ileocecal junction was due to edema and enlargement of the lips of the ileocecal valve. The cecum turns toward the left so that the terminal ileum approaches it from above. The ileum is not well enough filled to disclose its condition. *B*, the cecum, under pressure, shows less well the defect at the ileocecal junction (*1*) because the center of the cone was a little too low. It shows clearly a rounded defect (*2*) below the ileocecal junction which was reproduced on two successive days, and which was interpreted as a polyp but which apparently was due to the inverted stump of the appendix.

showed thickening of the wall with edema and ulceration of the mucosa of the lower 18 cm. of the ileum. The ileal side of the ileocecal valve was edematous and pendulous, projecting into the cecum (Fig. 5). The cecal walls appeared negative. No evidence of a polyp was found. The diagnosis was early regional enteritis. The patient has had no recurrence of the disease during one and one-half years since the operation.

COMMENT

The original description of the specimen in Case II gave no satisfactory explanation for the persistent shadow in the cecum which suggested a polyp. On the roentgenograms it seemed too far from the ileocecal junction to be due to the edematous valve, although at the time that was suggested as a possibility. On re-examination of the specimen with Dr. A. P. Stout, Director of the Department of Surgical Pathology, it seemed that the site of the stump of the appendix was definitely thickened and that, in the original flexible state of the wall, this could well have projected into the lumen sufficiently to produce the rounded area of diminished density in the barium shadow. This is undoubtedly an example of the phenomenon described by

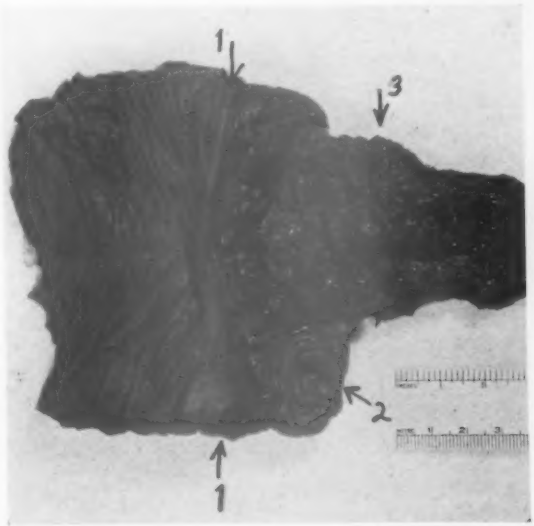

Fig. 5. Case II. The resected terminal ileum, cecum, and proximal ascending colon, somewhat shrunken and distorted. *1*, the thick, edematous lips of the ileocecal valve do not appear as large as they did in the fresh specimen. *2*, the inverted appendix stump which apparently produced the shadow in the cecum suggesting a polyp. *3*, the diseased terminal ileum with thickened edematous mucosal folds.

Weber and Good[2] (1940) and which, they said, could not be differentiated with certainty from a polyp.

Edema and "pouting" of the lips of the ileocecal valve is quite common in the specimens seen in our Department of Surgical Pathology after ileocolectomy for regional enteritis. The demonstration of enlargement of the ileocecal valve by barium enema, therefore, may be taken as a strong suggestion to look for this disease by means of a small intestine study after the ingestion of a barium suspension.

In Case 1 the origin of the hypertrophy underlying the edema of the valve lips is not clear. This edema of the mucosa was associated with edema of the terminal ileum visible on its serosal aspect. Edema of the intestinal wall has been described in deficiency states (Golden). This patient habitually took large amounts of alcohol and, because of nausea and vomiting, had been taking relatively little food for some time before the examination. She probably had a nutritional deficiency from lack of vitamins. No other cause could be found. Intussusception in adults is rare in the absence of a tumor, and no intussusception was found at operation. A slight intussusception at the time of the roentgen examination, two weeks before the operation, cannot be ruled out but it seems unlikely. The surgeon felt that the size of the ileocecal valve was sufficient to explain the shadow.

Cancer may arise in the margin of the ileocecal valve as well as anywhere else in the cecum. An example is shown in Figure 6. The defect at the ileocecal junction, however, is asymmetrical. It is conceivable that a small cancer might be located at either junction of the two lips so as to produce a symmetrical appearing defect around the ileocecal orifice, but it seems unlikely that the lumen would be demonstrated almost in the center of the defect as on the pressure roentgenograms in Case 1.

When this differential diagnostic problem presents itself—which will be rare—it

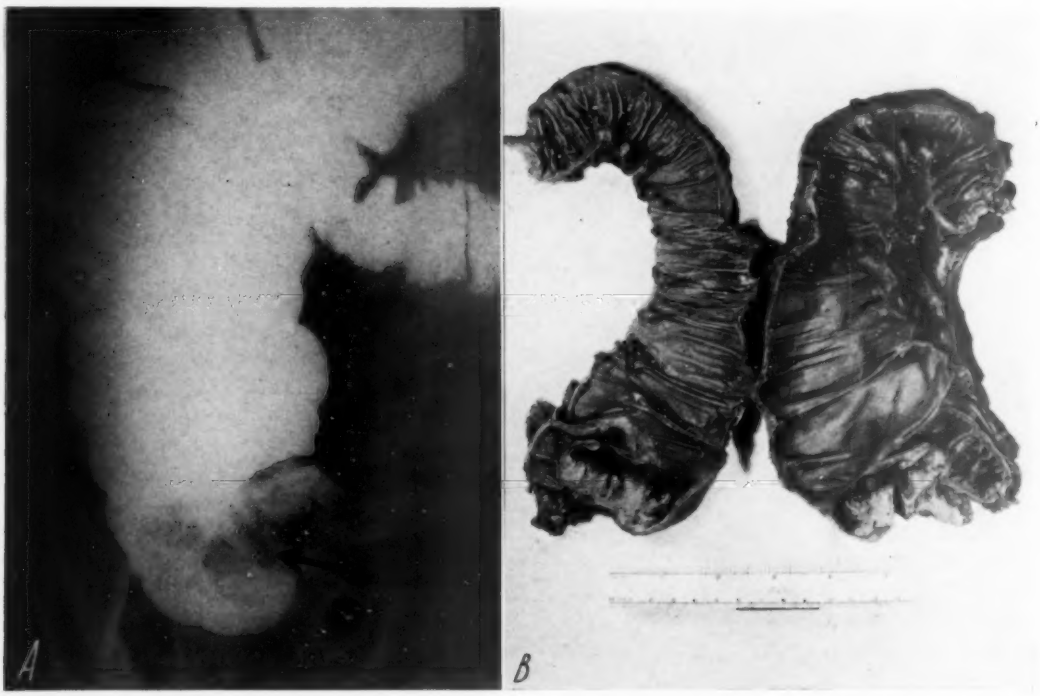

Fig. 6. Cancer of the cecum involving the lower margin of the ileocecal valve. The defect is asymmetrical.

is obvious that studies should be made not only by barium enema but also by barium given by mouth. Pressure roentgenograms of the ileocecal junction are to be highly recommended.

At the time the first draft of this paper was made no mention of enlargement of the ileocecal valve in the literature had come to my attention. In the Lysholm Number of *Acta radiologica*, which was received in the midsummer of 1942, Strömbeck,[1] in an article on terminal ileitis, describes it and shows an excellent example. It undoubtedly is a frequent occurrence in this condition. In the future, it will probably be demonstrated more frequently by roentgen methods. In our specimens the edema characteristically involves the mucosa on the ileal but not on the cecal side of the lips.

Another case has been very recently encountered in which a defect at the ileocecal junction was found (Fig. 7) similar to, but smaller than that of Case 1. It is not included as a case report as it was not proved. A big, paunchy fifty-eight year old man was studied because of nausea and vomiting. He was accustomed to take half a pint or more of liquor daily. No satisfactory explanation of his symptoms was found. The demonstration of the defect at the ileocecal junction raised the question of edema of the mucosa of the valve. In the absence of all local symptoms and signs, and in view of the findings in Case 1, the possibility of a mild deficiency state based upon alcoholism was suggested. Because liver extract contains something which affects favorably the disturbances in the small intestine in deficiency states, intramuscular injections of this material were given. Re-examination, twelve days later, showed very slight, if any, diminution in the defect produced by the ileocecal valve. The time interval is too short to be sure about this result. It is hoped that further studies can be made later.

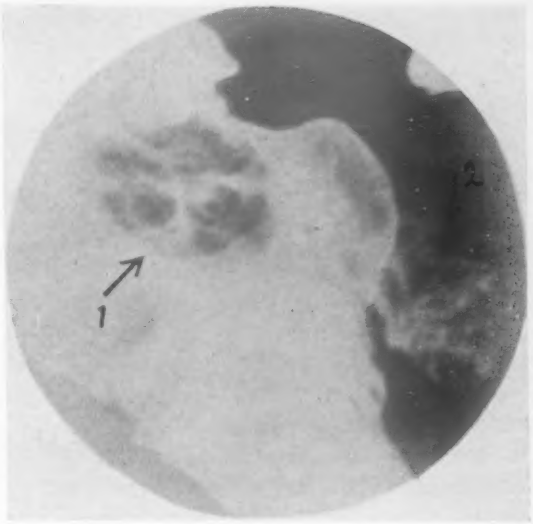

Fig. 7. Defect at the ileocecal junction in a third case, similar to that described in Case 1. The roentgenogram was made with slight pressure. *1*, the defect suggesting enlargement of the ileocecal valve. *2*, the terminal ileum passing behind the medial margin of the cecum.

SUMMARY

1. A case of apparent hypertrophy of the structures forming the ileocecal valve, associated with edema of the mucosa, and producing a roentgen defect simulating a slight ileocecal intussusception is presented.

2. A similar, but much smaller, defect was produced at the ileocecal junction by edema of the valve lips in a case of regional enteritis of the terminal ileum.

3. Edema and protrusion of the lips of the ileocecal valve is frequently seen in resected specimens of regional enteritis.*

I am indebted to Dr. A. Purdy Stout, Director of the Department of Surgical Pathology, for the photographs of the specimens reproduced herewith.

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* For discussion see page 31.

SIGMOIDITIS*

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INTRODUCTION

THIS presentation was undertaken with some hesitancy for the unwarranted subdivision of known pathologic processes into new clinical entities is to be discouraged and condemned. It is our opinion, however, that if one's observations are in disagreement with both the clinical and anticipated pathological process, a new disease entity may be under consideration. Repetition of these observations tends to substantiate this opinion. Thus it was that several years ago in the course of a barium enema study of the colon in a case of suspected diverticulitis, there first was observed the condition about to be described. The condition was a marked irritability and spasticity of the proximal portion of the sigmoid. No diverticula were demonstrated and the remainder of the colon was negative. This was regarded and reported as a localized inflammation of the colon; in this case, sigmoiditis. Shortly thereafter several similar cases were encountered and it was then anticipated that this might represent a new clinical entity worthy of recognition.

A review of five standard textbooks on diseases of the colon disclosed that the author of only one, Bacon,[1] recognizes "sigmoiditis" as an entity. All the others regarded inflammation of the sigmoid as a component of colitis. Nor did conversations with proctologists and gastroenterologists prove to be more enlightening, for they were in agreement that sigmoiditis was merely a manifestation of colitis.

Inasmuch as a perusal of the standard textbooks on diseases of the colon afforded but little support for the designation of sigmoiditis as an entity, the medical literature during the past twenty years was reviewed. The results were enlightening and most encouraging for many papers on "sigmoiditis" have appeared in European, and to a lesser extent, in the South American literature. The majority of these have been published during the past seven years. The fact that only one article appeared in North America, and this was eight years ago, not only justifies this presentation, but also emphasizes the observation that American physicians are not so cognizant of this disease entity as are their foreign colleagues.

This previous article,[2] a case report by Bargen and Weber of the Mayo Clinic, concerned a white male, aged forty-seven, whose clinical, proctoscopic and roentgenographic findings were in general agreement with our observations.

INCIDENCE

This problem was therefore regarded as a fertile field for investigation, particularly as the provisional clinical diagnosis had been incorrect in the cases coming to our attention. This was substantiated by a review of barium enema studies, which extended over a period of thirty-one consecutive months, and consisted of 489 examinations. Thirteen cases were encountered, making an incidence of 2.6 per cent. Of these 13 cases, 10 were active and 3 were regarded as chronic and relatively inactive. The 10 active cases were further subdivided into 5 unquestionable and 5 probable cases. If the latter group is excluded from this statistical study, the incidence is reduced to 1.6 per cent. Of the original grouping of 13 cases, 11 were females, and 2 males. The age of these patients ranged from thirty-seven to seventy-five years, the average being 56.5 years.

ETIOLOGY

At present, a consideration of the etiological factors must be conjectural, but it would seem probable that those pertinent

* From the Department of Roentgenology, Jefferson Medical College and Hospital, Philadelphia. Presented at the Forty-third Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 15–18, 1942.

to a more generalized colitis are also applicable here. The possibility that trauma might be a contributory factor cannot be excluded. This is suggested by the fatal termination of one of the cases to be reported, the patient having been repeatedly subjected to ill advised prostatic massage.

ROENTGEN DIAGNOSIS

It is recognized, of course, that under normal conditions, the distal end of the descending portion of the colon, as well as the proximal half of the sigmoid, is the most irritable portion of the colon. However, in the cases that initiated this study, the spasticity and irritability of the sigmoid were obviously in excess of normal and were restricted to this portion of the large intestine. In some instances these phenomena were most apparent roentgenoscopically, the roentgenograms presenting a fairly normal appearance. However, in the majority of cases, a permanent record was obtainable. It may be argued by some that these changes are merely manifestations of either a localized colitis, or the initial site of development of a more extensive colitis. Without disputing these viewpoints, it is felt that the attendant symptomatology warrants a distinction. Furthermore, so far as is known, none of these individuals has subsequently developed a more extensive or progressive colitis.

SYMPTOMS

A consideration of the symptomatology of this condition should recall to mind that lower abdominal pain, with cramps, gas, and perhaps alternating constipation and diarrhea, are always suggestive of a pathological condition of the sigmoid. The outstanding symptom associated with this condition is pain, often dull and aching in character, and usually limited to the lower abdomen, especially the left lower quadrant. This is frequently acute in onset and of relatively short duration, the majority of the patients having sought medical attention during the first week of the disease. In addition to pain, a disturbance of bowel habits is noted, either diarrhea or constipation, sometimes alternately. If constipated, the stools are hard, dry, and may be coated with either mucous or blood. In our cases which experienced rectal bleeding, proctoscopic examination revealed the presence of internal hemorrhoids, which had either become evident or were aggravated by this condition. The initial symptoms of several of the patients suggested disease of the urinary tract, and consisted of dysuria and frequency. Systemic symptoms were relatively mild, except in one case that terminated fatally, the cause of death being a generalized purulent peritonitis.

The most frequent tentative diagnosis was diverticulitis of the sigmoid. In several of the elderly patients, cancer was suspected. One case was diagnosed as colitis.

With the exception of one fatality, those cases that could be satisfactorily followed were free of complications or sequelae. However, several individuals included in this study showed a uniform reduction in the caliber of the sigmoid, as well as shortening of this segment of the colon, the remainder of the large intestine being negative. This appearance was unassociated with either spasticity or irritability, nor was there evidence of any localized pathologic process. It is possible that this shortening and narrowing of the sigmoid may represent a sequel of sigmoiditis. As in Bargen and Weber's patient, recurrences were noted in several instances.

DIFFERENTIAL DIAGNOSIS

In the consideration of differential diagnosis, it is felt that the presence of any antecedent disease process which could secondarily produce irritability and spasticity of the sigmoid precludes the diagnosis of sigmoiditis within the scope of this paper. Although in the light of our present knowledge, this conservative attitude is justifiable, it is possible that some cases of sigmoiditis are masked by an antecedent pathologic process. For example, an irritable spastic sigmoid presenting diverticula is regarded as a manifestation of

diverticulitis. Who can deny that in some instances this may be a primary sigmoiditis independent of a pre-existing diverticulosis?

The condition to be considered most frequently in the differential diagnosis of sigmoiditis is diverticulitis of the sigmoid. This is not only because of the frequency of this disease, but is also due to the similarity of the symptoms. As has just been mentioned, the presence of diverticula in conjunction with localized spasticity and irritability is usually accepted as evidence of diverticulitis. The differentiation between these two diseases therefore depends largely upon the presence or absence of diverticula. It must not be overlooked that occasionally small diverticula are observed at autopsy that were not demonstrated at previous proctoscopic or roentgenographic examinations.

Sigmoiditis secondary to pelvic inflammatory disease must also be excluded. Although usually limited to the female, the possibility of adnexal disease in the male should be kept in mind. In either event, the history and physical findings tend to prevent error. Furthermore, the roentgenographic examination not infrequently discloses the presence of an inflammatory mass with associated displacement of the sigmoid.

Inflammatory changes in the sigmoid secondary to radiation therapy are occasionally observed. These are usually in conjunction with cancer of the uterine cervix and are especially apt to follow radium and radon therapy. As the symptoms of these reactions occur within two or three weeks after the administration of the radiation, the relationship is obvious. In addition to the acute inflammatory reaction following radiation therapy, the possibility of post-irradiation cicatricial stenosis of the sigmoid developing some months or even years later is not to be overlooked. This may simulate a sequel of a primary sigmoiditis.

Endometrial implants may also result in a localized sigmoidal lesion. This condition, which is limited to females in the child-bearing period, may produce diverse symptoms and roentgenographic appearances. These are dependent upon the size and extent of invasion of the intestinal wall by the aberrant endometrial tissue. Symptoms of mild intestinal obstruction are frequently present, this condition becoming periodically intensified during the menses. If the mucosa is invaded, bleeding occurs. Roentgenographically, there is a localized reduction in the intestinal lumen, not infrequently eccentric in configuration. Spasticity and irritability are not conspicuous accompaniments. Ulceration, when present, is not associated with extensive tissue destruction.

Luetic involvement of the colon is usually productive in character and may be associated with superficial mucosal ulceration. The roentgenographic appearance is not pathognomonic and closely simulates an annular cancer. Diagnosis is dependent upon biopsy or the response to specific antiluetic therapy.

Chronic ulcerative colitis is seldom if ever restricted to the sigmoid, and therefore changes are also present in the other portions of the colon, especially the descending part.

Tuberculosis of the sigmoid, as one of several sites of involvement, is occasionally seen; extremely rarely is it encountered as a solitary lesion. The explanation apparently lies in the absence of Peyer's patches, for these accumulations of lymphoid tissue are sites of predilection for bacillary infections.

Lymphogranuloma venereum is another infectious process that may involve the sigmoid. Since this develops as an ascending infection from the rectum, the nature of the disease process is apparent. In the majority of cases, the clinical and pathologic diagnosis has been established before the patient is referred for roentgenographic examination.

The differentiation from cancer of the sigmoid does not usually offer any great diagnostic problem. However, certain cases are encountered where a primary cancer of

the colon is masked by an associated secondary inflammation.

TECHNIQUE OF ROENTGEN EXAMINATION

As in all roentgen studies of the gastrointestinal tract, roentgenoscopy is of paramount importance, supplementary appropriate roentgenograms being made. In the examination of the sigmoid, the barium sulphate suspension is permitted to flow while the patient is placed in the supine and various oblique and lateral positions. As the distal half of the sigmoid is beyond the reach of adequate palpation, it is essential that inspection shall yield the maximum amount of information. Furthermore, it is found that exposures made while the opaque suspension is flowing produces roentgenograms of greater diagnostic value. In the condition under consideration, the enema causes the patient some discomfort, as a result of which it is necessary to frequently interrupt the flow of the opaque medium, and occasionally to siphon off some of the contents. Failure to observe these precautions can nullify the entire examination. Moreover, the recollection of the discomfort incident to such a clumsily conducted examination may result in the patient's refusal to permit further roentgenographic studies. Aside from retardation of the flow of the opaque medium due to irritability, there is no evidence of obstruction. In none of the cases was there any indication of mucosal ulceration. The remainder of the colon, as well as the terminal ileum, was negative.

TREATMENT

Treatment of a conservative character has usually proved efficacious. This consists of a low residue diet; hot rectal irrigations of physiologic saline solution, and thorough atropinization with tincture of belladonna.

CASE REPORTS

The following case reports are representative of our experiences with this condition.

Case 1. H.S., a white male, aged seventy-five, was admitted to Jefferson Hospital on June 14, 1939, complaining of recurring pain across the lower abdomen, scrotum and rectum of six days' duration. The pain had first appeared after voiding, was rather severe and persisted for twenty-four hours. Local application of heat brought relief. Since that time there had been daily recurrences, initiated by voiding and rectal examination. (Incidentally his family physician had repeatedly massaged his prostate prior to admission to the hospital.)

Fig. 1. Case 1. Severe acute sigmoiditis, showing pronounced distortion and irregularity of the sigmoid. At roentgenoscopy this was associated with marked irritability and spasticity.

With the exception of diarrhea on the third day of his illness, he had been constipated and the stools were hard and dry.

Physical examination revealed a fairly well nourished, elderly male, apparently not experiencing pain, but obviously acutely ill. On admission his temperature was 101° F. (by mouth), pulse 84 and respirations 24. The abdomen was tense, and tenderness was noted in the left lower quadrant. Bladder dullness was elicited within a finger's breadth of the umbilicus. Rectal examination revealed a firm, elastic, enlarged prostate, not tender to palpation. The posterior wall of the rectum was pushed forward by a mass that was suggestive of a neoplasm. The possibility of either metastasis from the stomach or a primary cancer of the sigmoid was considered. The white blood count was 8,100.

Roentgenographic examination by means of a barium enema showed distortion and narrowing of the lumen of the sigmoid portion of the colon (Fig. 1). The location of the lesion as well

as localized abdominal rigidity prevented palpation. There was no evidence of diverticula. This condition was regarded as an inflammatory lesion, that is a sigmoiditis, cause undetermined. The possibility of an underlying neoplasm could not be excluded.

The patient's condition became progressively more unfavorable, coma intervened, and he died on June 19, 1939.

Autopsy disclosed: (*a*) A generalized acute purulent peritonitis. (*b*) The walls of the rectum, sigmoid and distal descending colon were markedly thickened, edematous, grayish-red in color and quite friable. No definite ulceration or penetration of the mucosa with inflammatory tissue was seen at any point. There was no evidence of infiltration with a tumor mass. The mucosa and walls of the remaining portions of the colon, as well as the stomach and small intestine, showed no abnormalities. (*c*) The bladder, prostate, and seminal vessels showed no gross abnormalities.

Comment. This is a valuable case, not only because it permitted correlation of the roentgenographic and autopsy findings, but also for the reason that it demonstrates the fatal potentialities of sigmoiditis. The precise rôle that repeated prostatic massage played in this case remains conjectural. Inasmuch as the patient's discomfort and the severity of his symptoms progressed with each massage, the relationship cannot be ignored.

Case II. F. A. S., a white female, aged sixty-two, was admitted to Jefferson Hospital on February 4, 1941. She complained of tenesmus, slight rectal bleeding associated with defecation, and frequency of stool. Proctoscopic examination revealed moderate constriction of the anal canal due to fibrosis. This was probably the result of a previous small anal ulcer. There was no infection or evidence of new growth about the canal. Moderately large internal hemorrhoids were noted. The rectal and sigmoid mucosa showed some inflammatory change and irritability which was regarded as the cause of the tenesmus and frequent bowel movements. Local application of iodoform and the administration of tincture of belladonna were instituted. Re-examination six days later showed a regression of the inflammatory reaction. The internal hemorrhoids were then injected with a sclerosing solution. Roentgen examination by means of a barium enema showed a deformity of the sigmoid which was quite spastic and irritable (Fig. 2). The patient's recovery was uneventful.

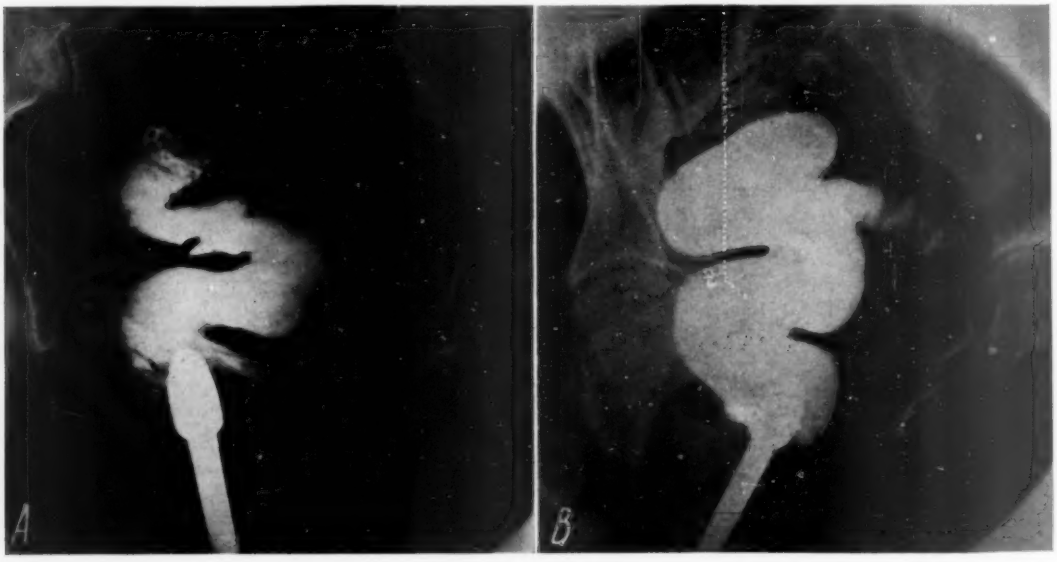

Fig. 2. Case II. Acute sigmoiditis of mild intensity. *A* shows initial irritability, none of the barium suspension having passed beyond the mid-sigmoid. *B* shows spasticity and poor filling of the proximal sigmoid despite distention of the rectosigmoid.

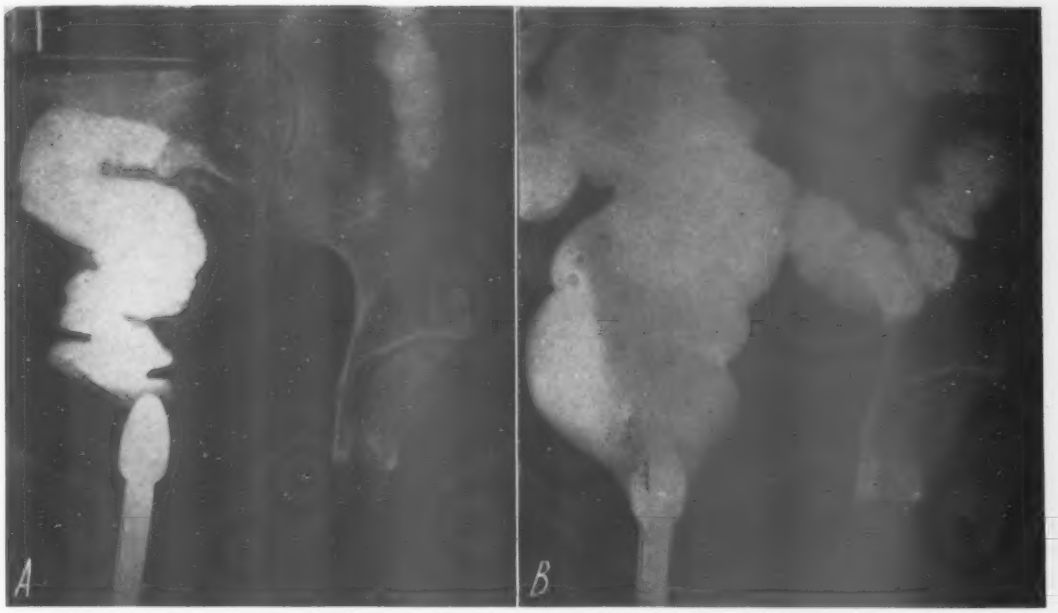

Fig. 3. Case III. Acute sigmoiditis. *A*, pronounced initial irritability of the proximal portion of sigmoid. *B*, after subsidence of spasticity and irritability, the sigmoid presents a relatively normal appearance. Note the dilatation of the rectosigmoid.

Comment. This probably represents a mild case of acute sigmoiditis that may run its entire course with little or no medical supervision. It is not unlikely that if patients complaining of slight rectal bleeding with mild associated pelvic discomfort were more frequently referred for roentgenographic examination of the colon, the recognition and statistical incidence of this entity would increase.

Case III. S. S., a white female, aged thirty-seven, was admitted to Jefferson Hospital on February 5, 1941, complaining of pain in the lower abdomen and rectum. This had been persistently present during the past year and was sometimes aggravated by walking downstairs and occasionally by urination. The pain was dull and heavy in character, never sharp. She was chronically constipated, necessitating the daily use of laxatives. Two years previously she had had an anterior anal fissure excised, her symptoms at that time being rectal bleeding and a burning rectal pain of two years' duration. Following operation this had not recurred.

Roentgen examination by means of a barium enema showed marked spasticity and irritability of the sigmoid and lower portion of the descending colon. There was no evidence of mucosal ulceration or of a proliferative lesion. The remainder of the colon was negative (Fig. 3).

Comment. This evidently represents an acute exacerbation of chronic sigmoiditis.

Case IV. S. B., a white female, aged fifty-five, admitted to Jefferson Hospital on November 8, 1938, complaining of diarrhea of two weeks' duration, followed a week later by intermittent, bearing-down pains. The patient stated that twenty-four hours after the onset of her illness she had taken castor oil. After this medication had been effective, the diarrhea persisted with the subsequent development of external hemorrhoids which probably were responsible for the bearing-down pains. Proctoscopic and roentgenographic examinations were advised, but the patient refused and left the hospital. She next sought medical aid in February, 1940, at which time she complained of sensitivity in the right side of the abdomen which had been present for some time. She stated that several weeks after she had left the hospital at the time of her previous admission, the diarrhea had gradually subsided and at present, aside from a tendency toward constipation, she had no bowel disturb-

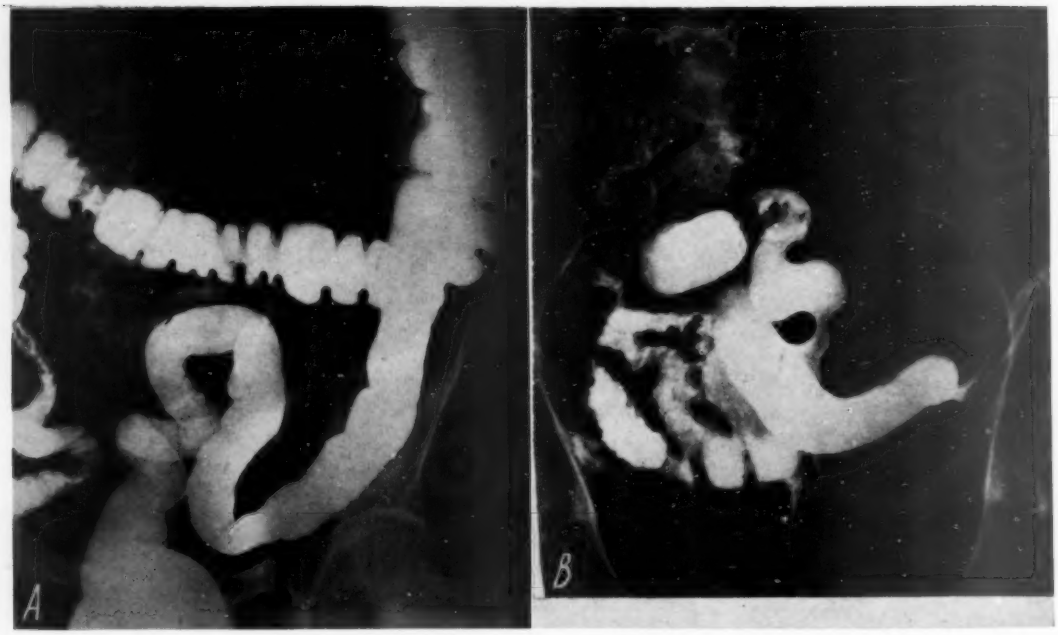

Fig. 4. Case IV. Old, inactive sigmoiditis. *A* shows the tubular, narrowed, smooth sigmoid, devoid of haustrations. *B*, after evacuation. Note the rigid, inelastic sigmoidal configuration, as well as the sharp line of demarcation at the sigmocolic junction.

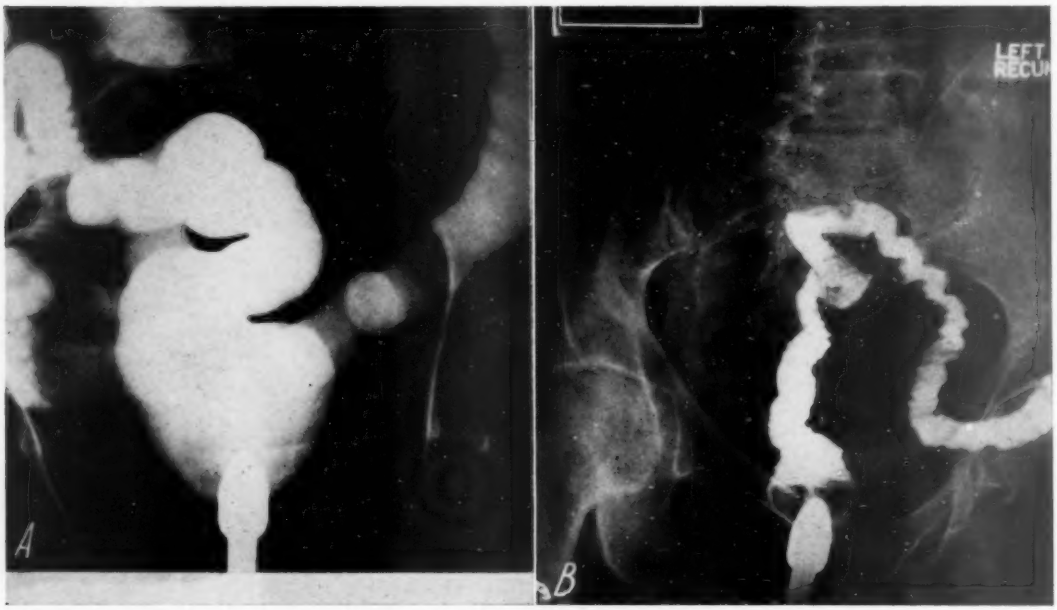

Fig. 5. Case V. Old, inactive sigmoiditis. *A*, sigmoid is devoid of haustrations and reduced in caliber. The latter condition was quite pronounced when compared with the remainder of the colon. It is observed that the diameter of the sigmoid is reduced to that of the distal ileum (extreme upper left). *B*, after evacuation, showing sigmoidal distortion.

ances. Sigmoidoscopic examination was negative for neoplastic disease, but showed considerable mucosal hyperemia. A barium enema examination revealed a tubular narrowing of the sigmoid which was smooth and devoid of haustrations (Fig. 4). The remainder of the colon was negative.

Comment. These findings were regarded as sequelae of an inactive old sigmoiditis.

Case v. P. S., a white female, aged sixty-four, was referred to the Department of Roentgenology, Jefferson Hospital on November 15, 1940, for a barium enema study. Her chief complaint was pain in the left lower quadrant which she associated with an injury to her left side that had been sustained five weeks previous to this examination. A roentgenographic examination immediately following the injury was negative for fracture. In the interim, the patient had been confined to bed because of severe pain. There were no symptoms referable to the colon. The barium enema study showed a marked reduction in the caliber of the sigmoid and lower descending colon. This portion of the intestinal tract had a tubular appearance and was devoid of haustral markings (Fig. 5). There was no evidence of irritability. Careful questioning of the patient failed to elicit a history of previous bowel disturbance. Nevertheless, the appearance of the colon seemed to warrant the diagnosis of an old quiescent sigmoiditis.

Comment. It is felt that the sigmoidal condition is entirely unrelated to the symptoms complained of by the patient following her recent injury. This case is presented because it serves to demonstrate an appearance, seen by all of us, that in the past has been either disregarded or else loosely classified as an old colitis.

CONCLUSIONS

(1) Primary sigmoiditis is a relatively unknown condition in this country, although it is recognized as a diagnostic entity in both Europe and South America.

(2) An incidence of approximately 2 per cent was noted on the basis of 489 consecutive roentgen examinations with the barium enema.

(3) Primary sigmoiditis is not infrequently confused with diverticulitis of the sigmoid, which it clinically simulates.

(4) The etiological factors pertinent to a generalized nonspecific colitis are probably applicable to primary sigmoiditis.

(5) Primary sigmoiditis is to be differentiated from diverticulitis of the sigmoid, lymphogranuloma venereum, tuberculous lesions, pelvic inflammatory disease, endometrial implants, lues, generalized nonspecific colitis, irradiation reactions, and malignant neoplastic disease.

(6) Treatment is conservative.

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DISCUSSION OF PAPERS BY DRS. GOLDEN AND CASPER

Dr. James T. Case, Chicago. It is a pleasure to hear these excellent papers of such interesting investigative character. It shows that our roentgenologists are studying their cases not only from the roentgen standpoint but clinically and that, of course, is the only way in which it should be done. Dr. Golden's paper demonstrates that dividends are paid for careful screen studies of our patients, especially during studies of the intestinal tract. It seems to me that, although the filling defects which he showed may have appeared without any pressure studies, they are brought out more definitely and will certainly be found more frequently when compression of the cecum is made at the time of the first roentgenoscopic study. This compression is better made with some nonopaque device instead of with the lead-gloved hand which impedes vision more than it helps.

I believe I have seen in a few cases the lesion to which Dr. Golden called attention and I just have not interpreted it properly. I thought it was probably due to a fecal bolus in the bowel. I sometimes worked on the idea that it probably was a cancer and I could not confirm it; but I shall look for it more carefully in the future.

As for sigmoiditis, I am sure I have seen the appearance shown in this roentgenogram a

great many times, and I have seen it localized in the sigmoid, or mostly localized in the sigmoid, in the majority of cases. I didn't realize until I heard this paper that sigmoiditis as such was so rarely spoken of. I have been accustomed to the use of this term for many years but did not consider that sigmoiditis was a lesion by itself. I believe there is still a question as to whether it is an entity or whether it is not a part of a more generalized colitis, admitting, of course, that it is usually more pronounced in the sigmoid region. Dr. A. W. George a great many years ago called attention to an irritable state of the sigmoid which, before I saw the films shown today, I thought would probably correspond to what the author was describing. It was later emphasized by Spriggs and Marxer, of England, as the "prediverticular stage of diverticulitis." Spriggs and Marxer have shown films, and I am sure many of us have seen films, of cases which looked like sigmoiditis, in which careful study of the colonic shadows showed mucosal herniations, very small ones, the size of pinheads, which, being watched through the years, were seen to develop into good-sized diverticula. Until I saw Dr. Casper's films, I had an idea that was what he was talking about; but having seen the films, it seems to me that they are describing a true colitis, which is more prominent in the sigmoid. As I say, however, I question whether it is an entity existing in the sigmoid alone or whether we find it most pronounced in the sigmoid with repercussions in the cecum.

I am very much interested in the study. I did not hear whether or not there was bleeding in these cases. In most of the similar cases in our studies where we have seen this aspect of the sigmoid we have found that bleeding is one of the symptoms, and have considered it as an ulcerative type of colitis which was more or less pronounced in the sigmoid.

Dr. Karl Kornblum, Philadelphia. I should like to say for Dr. Casper that we at Jefferson Hospital are not so much concerned with establishing sigmoiditis as a clinical entity. Granted that this may be simply a localized colitis, which it really is, the point is that when a roentgenologist examines these cases, he usually makes a diagnosis of diverticulitis. One may find all the evidence of diverticulitis with the exception of diverticula, and then as in some of our own cases we have simply reported the case as negative. I think that this is a mistake because these patients have a real pathologic process.

I am glad to hear Dr. Case say that he has been using the term "sigmoiditis" for many years and Dr. Golden has told me that he also has been using the term "sigmoiditis" for a long time. It is too bad that it has not found its way into the literature more often and that it is not recognized by the clinicians as a condition that should be treated. As I say, the only reason for bringing this subject to your attention is that we should not call these cases negative from the clinical point of view. They have a pathologic condition which requires treatment.

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GASTRIC HERNIATION AT THE ESOPHAGEAL HIATUS*

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INTRODUCTION

ALL forms and phases of herniation at different sites in the diaphragm have been abundantly reported. During the years 1930 to 1939 inclusive, 673 articles on various phases of diaphragmatic herniation were added to the literature as listed by the Quarterly Cumulative Index Medicus. Yet from the point of view of the roentgenologist, it seems desirable to review and to focus still further attention on the group of cases in which a small or large portion of the stomach herniates at the esophageal hiatus. This is the most important group in adults, far outnumbering the traumatic ones; those at the foramina of Morgagni; or those at the common sites in infancy, the persistent pleuroperitoneal canals of Bochdalek. It has long been recognized that troublesome symptoms do not occur in all patients who present this abnormality. The great variety of symptoms presented by the patients who do have discomfort has earned for hiatus hernia the designation, "masquerader of the upper abdomen," as stated by Reid.[9] The typical symptoms of anginoid pain, worse after meals, aggravated by the horizontal position, and frequently accentuated by emotional stress are becoming legendary for this condition. Special vigilance is required to demonstrate this finding in patients in whom the clinical picture is much less distinct, e.g., only hematemesis on repeated occasions or pyrosis alone. It is particularly true of this latter group that more searching roentgenological investigation would be helpful if established diagnostic criteria could be broadened dependably.

By popular medical usage the phrase hiatus hernia, unqualified, refers only to the herniation which occurs at the esophageal hiatus. Other designations used for the same condition include epiphrenic gastric pouch, para-esophageal hernia, gastro-esophageal hernia, hernia of the cardiac end of the stomach, and hernia of the gastric fundus.

ANATOMY

There is intimate proximity of the esophagogastric junction and the cardia of the stomach to the heart, lungs and left lobe of the liver. This makes the anatomical aspects[2] of this condition important. Also the normal anatomical contour of the terminal portion of the esophagus should be borne in mind lest the ampullary portion be erroneously thought of as a small gastric herniation which has assumed the relative position normally occupied by the ampulla phrenica. To review anatomical details, the ampullary portion of the esophagus is between[3] the crura of the diaphragm to which it is attached by fibrous connective tissue. The abdominal portion is the short intermediate esophageal broadening between the ampulla phrenica and the stomach. The antrum cardiacum, as this portion is called, blends imperceptibly with the adjacent portion of the stomach when the latter is distended.

It is significant that the nerve supply of the distal esophagus, both parasympathetic and sympathetic, is closely related to that of neighboring organs. The vagal fibers which supply motor and secretory innervation are closely related to similar vagal fibers supplying the aorta, liver and stomach. The same sympathetic plexus which furnishes fibers to the lower esophagus furnishes similarly other neighboring lower mediastinal and upper abdominal organs. The innervation of the crura of the diaphragm by the phrenic nerve bears only an indirect relation to the esophagus in a normal individual.

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PHYSIOLOGY

Awareness of certain physiological facts is a prerequisite to proper interpretation of various aspects of the problem of hiatus herniation of the stomach. Experimental work has revealed[6,7] that pain is referred to different external levels from localized stimuli at the proximal, middle or distal third of the esophagus. Increased tension in the proximal portion of the esophagus

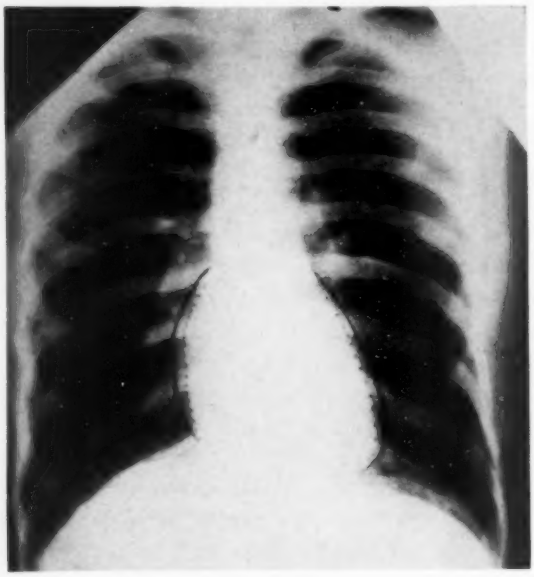

FIG. 1. Superimposed roentgenograms of a normal individual with the same factors except dotted lines represent heart borders with Valsalva effort. Solid lines represent heart borders during Müller effort.

tends to cause a sensation of nausea at the back of the throat. Chest wall discomfort from this section may be referred to the manubrial region and near the suprasternal notch. Stimuli from the middle third of the esophagus cause reference of pain to the mid-sternal region. It has been shown that distention of a balloon in the distal portion of the esophagus of a normal individual will produce definite anginoid pain. Pyrosis or heartburn can arise in a similar manner from distention or chemical irritation[12] in this portion.

It is known that profound emotional disturbances incite[7] local motor and sensory over-stimulation. At such times the esophagus and stomach are markedly spastic. This is of particular significance in hiatus herniation since the displaced esophagogastric junction, already functionally impaired, may be the site of abnormal congestion and chemical irritation.

The application of physiological principles of pressure variations in the thorax[13] and abdomen partially explains the relation of hiatus herniation to pregnancy and large abdominal neoplasms. As a point of academic and some diagnostic significance, intrathoracic pressures may be varied during roentgenoscopy by the Valsalva and Müller experiments. Natvig[8] has shown by roentgenograms the contrast in size of vascular and mediastinal structures at the two extremes of intrathoracic pressure as seen here in Figure 1 illustrating a normal individual. In the Valsalva effort, intra-abdominal and intrathoracic pressures are increased by attempting expiration with closed upper passages after complete inspiration. More adaptable to the study of gastric herniation is the Müller effort, in which the patient attempts to inspire with closed passages after complete expiration. By reducing the intrathoracic pressure this tends to cause maximum filling of a herniated portion of the stomach.

Acquired physiological and morphological conditions contribute much to the development of hiatus herniation. Three factors, as reported by Eisen,[4] contribute to the greater frequency of this condition in females: pregnancy, high incidence of chronic constipation, and frequent post-menopausal obesity. These all serve to increase intra-abdominal pressure. It has been observed that in addition to causing gastric herniation during the latter months of pregnancy, the residual dilatation of the esophageal hiatus is an important factor in the persistence or recurrence of the herniation during later life.

Schatzki[11] has shown a great frequency of gastric herniation in elderly individuals. In 73.3 per cent of 30 aged male patients he found that some degree of herniation

could be demonstrated. Explanations offered for this occurrence include diminished elasticity of connective tissue in the aged, relaxation or lengthening of muscle fibers, and new regional adipose tissue deposits. All these factors contribute to the laxity which in turn is conducive to hiatus herniation.

PATHOLOGY

The functional pathology of herniation at the esophageal hiatus is worthy of close attention. Interference with the vascular supply of the herniated portion of stomach has been observed gastroscopically as well as in postmortem studies to produce local congestion of the herniated mucosa and gastritis. There may be erosion of superficial vessels and ulceration as a result of persistence of this process. Pyrosis easily results from the retrograde passage of gastric contents into the terminal esophagus. Repeated instances of this may lead to esophageal peptic ulcer formation with all its possible complications. Local esophageal spasm is not a surprising consequence of such regurgitation.

Traction on an incarcerated portion of the esophagus by fibrous adhesions to the left dome of the diaphragm and adjacent structures may become a prominent feature in those cases which show marked local circulatory embarrassment. The presence of such adhesions has been observed as the explanation for pain referable to the left shoulder.[7]

ROENTGENOLOGY

In reviewing the incidence of hiatus herniation among 1,500 upper gastrointestinal examinations a frequency of 3.5 per cent was observed. This is based on exclusion of those cases of equivocal slight displacement of the esophagogastric junction and those in which no persistent epiphrenic pouch could be demonstrated with the patient breathing normally. Undoubtedly the incidence would have been much higher except for a large number of males and of nonpregnant females, all less than thirty years of age, for no instance of herniation was observed in this group. Further, the incidence would have been lower except for the fact that in addition to barium administration with the patient erect, barium was given with the patient supine and often in the prone position as well. Frequently the clinical diagnosis by the referring physician was carcinoma and even more frequently coronary disease or gallbladder disease, but almost never the differential diagnosis of peptic ulcer.

A peculiar contour in the region of the cardiac shadow (Fig. 2) may result from a frequently asymptomatic protrusion of a large part of the stomach into the lower thorax. In the absence of a visible gas bubble in the stomach (Fig. 3) the cause may not be obvious until barium is given. If asymptomatic, patients of this group often are of more practical interest to the roentgenologist than to the referring physician. It should be noted that these cases with normal esophageal length differ from true thoracic stomachs. Although radical therapeutic steps may not be needed, early recognition may avoid an erroneous diagnosis of cardiac or mediastinal disease.

Close attention to the path of barium in the distal esophagus as stressed by Carty,[1] will, when the pouch is quite small, frequently reveal an upward course (Fig. 4) as the mixture is about to reach the stomach. But as a general rule even these hernias are easier to visualize in their true extent by placing the patient in the supine position in slight Trendelenburg position and giving additional barium. One point which seems worthy of greater attention is that of having the patient alter pressures by the Valsalva effort and Müller effort, as suggested above. The following case history illustrates that with a hiatus of markedly broadened caliber there may be a gross retrograde flow of barium into the herniated portion of the stomach. This clue to the caliber of the hiatus assumes greater importance when considered with other possible observations.

Case 1. M. P., an unmarried seamstress, aged seventy, entered the hospital complaining

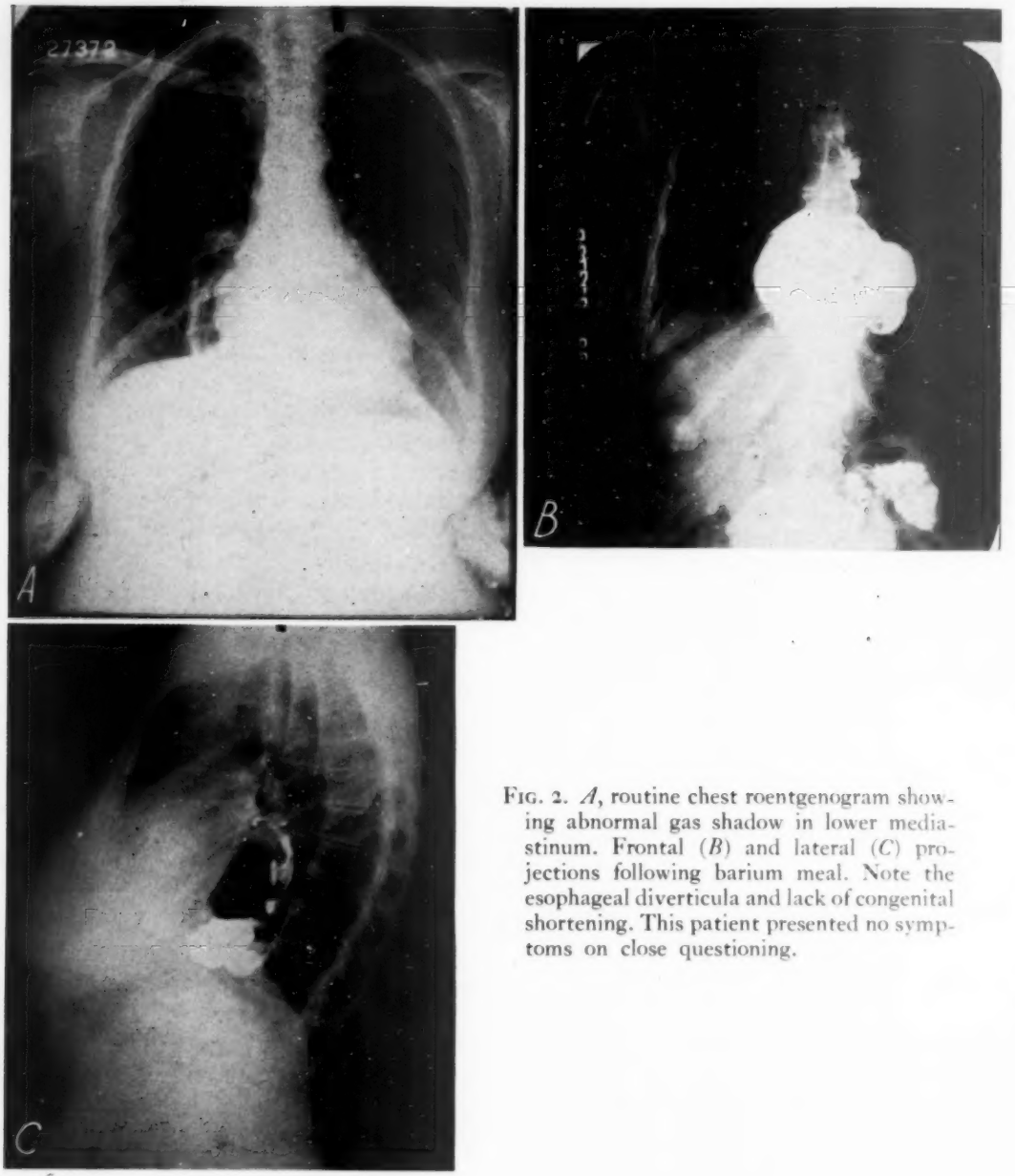

Fig. 2. *A*, routine chest roentgenogram showing abnormal gas shadow in lower mediastinum. Frontal (*B*) and lateral (*C*) projections following barium meal. Note the esophageal diverticula and lack of congenital shortening. This patient presented no symptoms on close questioning.

of intermittent epigastric pain which had varied from sharp to dull in character for six months. The tendency of the pain to radiate to the chest wall and shoulder was ordinarily most noticeable at night. Alkalies gave some relief when taken on a regular schedule daily. A definite postprandial increase in pain was noted with nausea and vomiting occasionally. Some dark brown vomitus was considered to contain blood. A loss of only 5 pounds had occurred.

The tentative diagnosis was early gastric cancer from the above recorded symptoms and the physical findings.

An examination of the upper gastrointestinal tract revealed protrusion of the proximal portion of the stomach through the esophageal hiatus into the thorax (Fig. 5). The esophageal hiatus showed marked enlargement so that change in abdominal and thoracic pressures by Valsalva and Müller efforts caused rapid distention and re-distention of the herniated por-

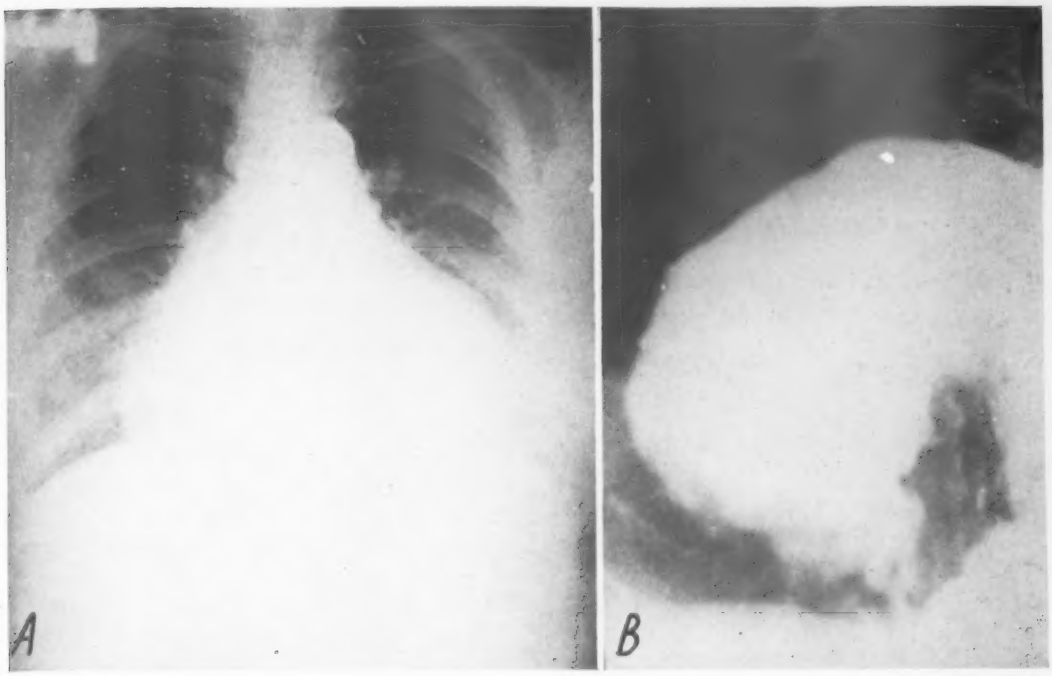

Fig. 3. *A*, abnormal cardiac contour without gas shadows suggestive of herniated stomach. *B*, large amount of stomach (22 cm.) herniated into lower mediastinum through very broad hiatus. No symptoms on close questioning.

tion. The remainder of the upper gastrointestinal tract was found to be normal. There was no evidence of cardiovascular, pulmonary or bilary tract disease.

The contour of the normal esophageal ampulla phrenica and mucosal pattern should be carefully established (Fig. 6). In some cases the distinction is obvious, but in others multiple fluorographic exposures are valuable to aid in establishing these important points. To see gastric rugae traversing the hiatus suffices for a positive diagnosis of the presence of herniation.

From roentgenographic evidence alone and from casual roentgenoscopic observation, a gastric diverticulum in the usual location at the proximal lesser curvature

Fig. 4. Characteristic upward swing of extreme distal esophageal portion of barium stream signifying presence of small gastric herniation.

Fig. 5. Case 1. *A*, during ingestion of barium with patient supine and in Valsalva effort. *B*, same patient immediately afterward during Müller effort. Increase in content of herniated portion of the stomach resulted from retrograde flow of barium. Note the relatively broad hiatus.

Fig. 6. Contour of esophageal ampulla phrenica. Note its proximal displacement by a small gastric hernia. Typical gastric rugae traverse the hiatus.

toward the posterior wall, where irregularly converging muscle layers contribute a weakness in the wall, may suggest herniation (Fig. 7). The complete absence of any rugal pattern as well as the actual subphrenic location of the diverticulum suffices to differentiate it from hiatus hernia. Lower esophageal diverticula (Fig. 2) may be excluded by visualizing their exact level of origin in relation to the gastroesophageal junction and by the smooth contour of their walls.

An hour-glass stomach may be closely simulated from the standpoint of gastric contour alone by the constriction at the hiatus, but the ease with which the upper part can be shown to be above the diaphragm makes differential diagnosis a simple matter. Eventration will also cause marked distortion of gastric contour but in this situation lower mediastinal relations are altered as well by displacement to the right, while in gastric herniation through the hiatus it is not difficult to show that the stomach is actually in the lower mediastinum.

Among any group of cases with roentgenographic evidence of hiatus herniation a few will have prominent rugal folds persistently. This fact, supported by antemortem and postmortem observations of congested folds, deserves particular study and attention. Logically the most important single factor to influence this occurrence would be that of vascular interference. This in turn contributes to ulceration and predisposes to the frequently observed hemorrhage in this condition.

Case II. I. J. B., a housewife, aged fifty-five, entered the hospital complaining of upper abdominal pain and indigestion of twenty years' duration. For two years before admission discomfort had been increasingly severe. An episode of vomiting was followed by tarry stools. Study of the patient by surgical and medical consultants resulted in the tentative diagnosis of gallbladder disease. A medical consultant made a disgnosis of coronary disease.

Further study, including upper gastrointestinal examination, showed gastric herniation at the esophageal hiatus. There were no gallstones demonstrable by cholecystography.

The prominent rugal pattern in the herniated portion of the stomach (Fig. 8) was considered suggestive of vascular interference and signifi-

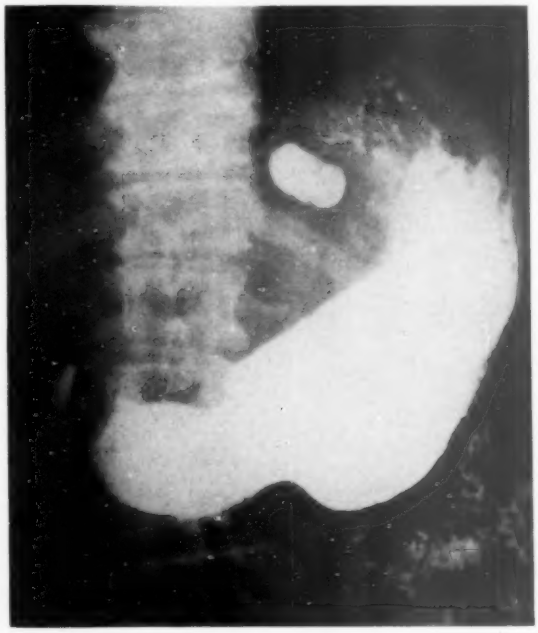

Fig. 7. A gastric diverticulum at the typical site. Resemblance to a small hiatus hernia in this projection. Note absence of rugal pattern.

cant constriction. This fact in the absence of other evidence of disease seemed to justify reference of symptoms to the esophageal hiatus.

Accurate demonstration of complete reducibility of the herniated portion of the stomach, or lack of reducibility, contributes much to a sound understanding of any given case. This often requires observation in various positions, for the stomach may be persistently in the thorax and merely distended to varying degrees or it may act as a sliding protrusion. Available evidence suggests that the mobile herniation is less likely to produce symptoms while the fixed hernial sac, either because of a very small orifice or fibrous connective tissue bands or both, may cause considerable discomfort.

Rigler and Eneboe[10] found 18 per cent of pregnancies to be accompanied by hiatus hernia during the last trimester. Evans and Bouslog[5] have shown the relation of pyrosis in the latter part of pregnancy to hiatus herniation of the stomach from increased intra-abdominal pressure. The following case history presents a similar instance of gastric herniation which appeared coincident with the enlargement of an abdominal tumor.

Case III. H. W., housewife, aged fifty-six, entered the hospital complaining of abdominal discomfort. Originally the symptoms were minimal. A roentgen investigation at the onset of her symptoms thirty months previously had shown an oval 4 cm. tumor adjacent to the distal greater curvature of the stomach, but situated posteriorly opposite the junction of middle and distal thirds. Her symptoms were so slight that she declined the exploratory operation recommended at that time. There was no suggestion of gastric herniation at the esophageal hiatus on this occasion.

Abdominal swelling gradually increased so that she was hospitalized for treatment. Distention, upper abdominal discomfort and substernal pain were quite troublesome. Physical examination revealed cachexia, ascites and edema of the lower extremities. A large extra-alimentary tumor which reached as far distally as the umbilicus and which could not be defined proximally because of the costal margins,

Fig. 8. Case II. Marked prominence of rugal pattern in herniated portion of stomach. Patient had a persistently small caliber of the esophageal hiatus.

was found. A typical small herniation at the esophageal hiatus was easily and persistently demonstrated at the time of upper gastrointestinal roentgen study.

The large abdominal tumor (proved at operation to be hemangio-endothelioma of retroperitoneal origin) simulated the abdominal enlargement of late pregnancy. The hiatus hernia (Fig. 9) may be assumed to have resulted from the accompanying increased intra-abdominal pressure.

SUMMARY

Hiatus hernia is least frequent in males and nulliparous females under thirty years of age. Most cases occur in well nourished individuals past middle age. Like diverticulosis, gastric herniation at the esophageal hiatus may exist without symptoms but, like diverticulitis, it may assume great significance in certain cases. The decided difficulty which sometimes occurs in distinguishing clinically this condition from

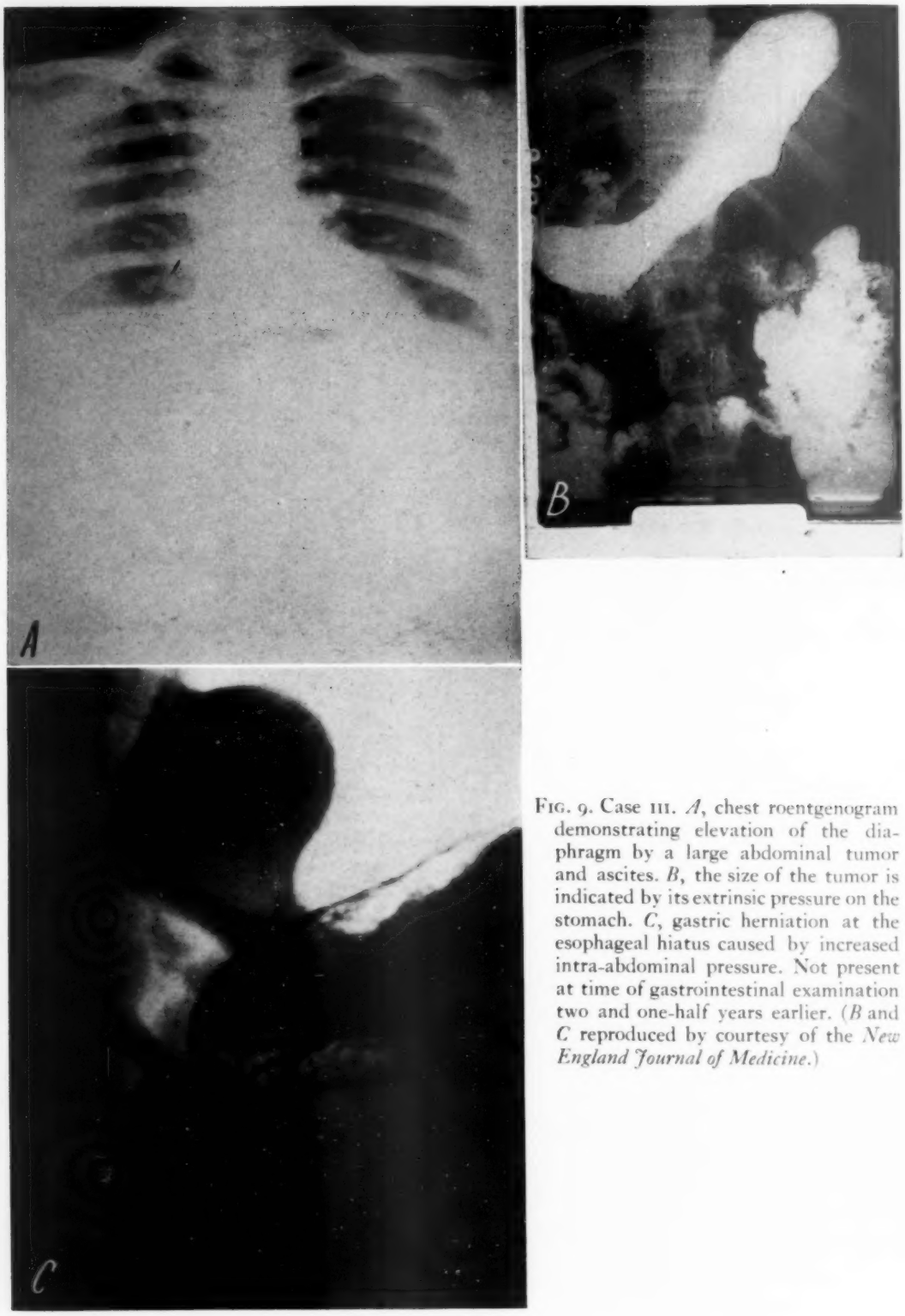

FIG. 9. Case III. *A*, chest roentgenogram demonstrating elevation of the diaphragm by a large abdominal tumor and ascites. *B*, the size of the tumor is indicated by its extrinsic pressure on the stomach. *C*, gastric herniation at the esophageal hiatus caused by increased intra-abdominal pressure. Not present at time of gastrointestinal examination two and one-half years earlier. (*B* and *C* reproduced by courtesy of the *New England Journal of Medicine*.)

gallbladder disease and from coronary disease in particular, contributes to its general medical importance. The hematemesis and the type of pain are often clinically suggestive of cancer but not likely to be confused with peptic ulcer. Timely recognition of hiatus herniation may avoid a needless cardiac regimen or unnecessary surgical procedures in patients where the diagnosis is least obvious.

Thus it behooves the roentgenologist to obtain all possible roentgenoscopic and roentgenographic evidence on each patient who has hiatus herniation for proper evaluation of the significance of this finding. The patient should be observed during ingestion of barium in the supine and prone positions as well as the erect. Estimation of a degree of gastric constriction which occurs at the hiatus, estimation of mobility of the stomach in relation to the hiatus, and attention to the rugal pattern in the herniated portion of the stomach are of paramount importance.

CONCLUSIONS

1. Mobility and the degree of constriction should be estimated as nearly as possible in each patient who has gastric herniation because of the relation of the presence of incarceration and adhesions to symptoms. The observation of the barium-filled stomach in the supine patient during the Müller effort is suggested as an aid for study of functional caliber of the hiatus.

2. Fluorographic and other methods of complete roentgen demonstration of mucosal pattern in the herniated portion of the stomach deserves more attention because of the association of mucosal congestion with symptoms.

3. A broadly dilated esophageal hiatus with a freely mobile and distensible herniating portion of stomach and normal rugal pattern is least often connected with symptoms. Conversely, a portion of stomach persistently herniated at the hiatus with no mobility, limited distensibility and marked prominence of rugal pattern is most likely directly productive of symptoms.

4. Large abdominal tumors or large accumulations of ascitic fluid or both may cause herniation of the stomach by increase in intra-abdominal pressure.

5. Hiatus hernia is almost never confused clinically with peptic ulcer but is frequently confused with gastric cancer.

6. Hiatus hernia rarely produces dysphagia.

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LIQUEFACTION NECROSIS IN BILATERAL SYMMETRICAL CONGLOMERATE LESIONS OF ANTHRACOSILICOSIS OF THE LUNG

REPORT OF CASE

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THE case to be reported here showed liquefaction necrosis in bilateral symmetrical conglomerate lesions of anthracosilicosis of the lungs, not complicated by tuberculosis, and the roentgen appearance resembled consolidation rather than cavitation. Death was caused by cancer of the stomach and during the patient's final illness the pulmonary findings raised the question of metastasis. My interest was further engaged because the man had not been exposed to silica after the year 1896 and his only exposure was that of a pick miner in a soft coal mine.

REPORT OF CASE

The patient, an adult white male, aged sixty-three, came to the hospital because of pain in the back, and after five weeks he died of gastric cancer. During the first two weeks of his hospital stay his temperature rose to 100° F. at 6 P.M. and it was normal the rest of the day. His pulse rate was 80 per minute. In the last three weeks his temperature varied between 100 and 101° F. day and night and his pulse rate was about 100. Chest symptoms were absent. He did not have cough, dyspnea, hemoptysis or expectoration.

FIG. 1. Roentgenogram of chest shows bilateral symmetrical conglomerate lesions of anthracosilicosis in the infraclavicular region of each lung which on pathological examination were found to be cavities filled with black, viscid material.

Occupational History. This patient worked as a pick miner in a soft coal mine for twelve years, from 1884 to 1896. From 1896 to 1940 he worked as a railway clerk in the baggage department. Careful inquiry was made for other exposures to silica but none could be found.

Physical Examination. Inspection showed symmetrical chest with equal normal expansion. Palpation showed equal normal tactile fremitus on both sides. Percussion revealed a small area of dullness in the upper anterior zone of the chest on both sides. Auscultation showed diminished breath sounds in the upper anterior zone of each lung. There were some friction sounds but no moist or musical râles.

Laboratory Findings. The routine laboratory procedures were normal or unimportant except the following:

Sputum: The sputum was greenish, purulent, granular, foul smelling, acid reaction and contained flecks of mucopus but no blood. Elastic tissue was not present and the tubercle bacillus could not be demonstrated in smears.

Tuberculin Test: Intradermal injection of 1/100 mg. of old tuberculin did not produce local reaction.

The erythrocyte sedimentation rate was 18 mm. in thirty minutes.

Roentgen Findings. The roentgenogram of the chest taken one month before death showed a diffuse, uniform and irregular nodulation throughout the entire chest, except at the extreme apices (Fig. 1). There was a conglomerate shadow in either subclavicular area. The hilar

Fig. 2. Photographs of lungs show cavitation in each upper lobe after removal of products of liquefaction necrosis of conglomerate lesions of anthracosilicosis.

shadows were somewhat increased. The heart was at the upper limits of normal in the transverse diameter. The aorta was tortuous and the knob was quite prominent. These findings were suggestive of an arteriosclerotic heart. The mottling in the lung fields could have been due to silicosis, metastatic cancer or miliary tuberculosis, with the evidence favoring silicosis.

It was learned that the patient visited a prominent clinic in September, 1927. The chest roentgenogram at that time showed an infiltration of both lung fields which was thought to be pneumoconiosis. Unfortunately the roentgenogram of 1927 had been destroyed and could not be compared with Figure 1.

Autopsy. The findings at autopsy were as follows:

Thorax: When the thorax was opened, the right thoracic cavity was found to contain about 200 cc. of amber-colored fluid; the left was free of fluid. The upper lobe of each lung was attached to the thorax by a heavy fibrous adhesion. The lungs were black, and numerous emphysematous pouches were seen on the surface. The heart lay free in the pericardial sac which contained about 20 cc. of clear fluid.

Left lung: The left lung was black over the entire surface; it was partially collapsed and was gummy in consistency (Fig. 2). On the anterior surface of the upper lobe there was a stellate scar and beneath this there was induration. On section this zone was found to be a cavity filled with foul smelling, tarry fluid. The anterior wall of this cavity measured 0.5 cm. in thickness. It was firm and gummy due to the intense infiltration of black coal dust. The cavity measured 5 cm. in diameter and it was fairly regular in outline. The internal surface was covered with black mud which could be scraped from it with very little pressure. Four stalagmites were present but none of them extended across the cavity. Near the outer edge of the upper lobe at the anterior surface a hard area 1 cm. in diameter was present; section through this showed an irregularly circular zone of black concentrated coal dust. Throughout the lobe small nodules were felt and on section these dense black nodules were seen. Each measured about 0.2 cm. in diameter. The surrounding lung tissue in the formalin fixed specimen was gray in color; in the fresh specimen the tissue was darker and all surfaces became soiled with the black fluid that escaped from the cavity. The pleura was darker than the underlying lung tissue. One cord-like fibrous adhesion was attached to the apex and numerous heavy adhesions were seen between the lobes.

The lower lobe had a hard nodular zone close to the cavity of the upper lobe. On section through this area a small cavity 0.8 cm. in diameter was seen. The wall was black and gummy; the inside surface was black and ragged; the

cavity was occupied by black, thick, muddy coal dust. The lower lobe also was nodular and on section the cut surface showed black circular or oval nodules each of which measured 0.2 cm. in diameter; these were surrounded by gray lung tissue. In the collapsed fixed lung there were about 12 nodules per square inch but they varied in number in different locations.

Right Lung (Fig. 2): The right lung had the same general appearance as the left except that the periphery of the lobes had more emphysematous blebs and bullae. In the upper lobe the anterior surface showed scarring and puckering. On section through this zone a cavity was found which was filled with black, sticky, tarry fluid. The fluid seemed to escape as if under pressure and gave the impression that the cavity had been completely filled. The wall measured 1 cm. in thickness, the cavity measured 7 cm. in diameter, the surface had ten stalagmites but none of these projections extended completely across the cavity. The surface of the cavity was ragged and with slight pressure one could scrape away muddy black material. There were no openings on the surface that would permit fluids to escape.

Microscopic Examination.

Right Lung: The microscopic section showed the portion of lung that extended from the free surface of the cavity to the pleura and can best be divided into the following zones.

Zone 1—This zone was a narrow, irregular area of black pigment lying on the underlying hyaline tissue.

Zone 2—This was a zone of fibrosis that was divided into two equal parts: first, an inner layer of hyalinized connective tissue containing sparse deposits of brown pigment and an outer layer of fibrous tissue showing a very heavy deposit of black pigment. In this zone the blood vessels showed marked obliterative endarteritis with thickening of the intima and reduction in the size of the lumen with very few showing complete obliteration. There was also a fairly marked infiltration of lymphocytes and a few polymorphonuclears.

Zone 3—This was an area of emphysematous lung tissue with small deposits of black pigment.

Zone 4—This was a subpleural area showing condensed pigmentation.

Zone 5—This was the pleura.

Neither tuberculosis nor metastatic cancer was seen in these sections.

Left Lung: A corresponding section of the left lung differed from that of the right in two respects: first, the blood vessels showed a greater degree of endarteritis and second, the lung tissue outside the fibrous nodule showed less emphysema and more inflammatory reaction. Deposits of pigment were seen in the intimal and muscular layers of blood vessels.

Abdomen: The autopsy revealed an annular carcinoma of the stomach adjacent to the esophageal attachment. The tumor caused such a great reduction in the size of the opening that one would not expect liquids to go through. Behind the stomach there was a large mass of cancer involving the liver, stomach, duodenum and pancreas.

Examination of fluid and tissue from the right lung cavity showed the fluid to be black, sticky, thick and foul smelling. Microscopic examination showed many black particles.

Numerous smears were examined but tubercle bacilli were not found. Aerobic broth culture of the fluid yielded a non-hemolytic streptococcus. One portion of the fluid was sent for examination to Dr. William B. Fulton, Director of the Bureau of Industrial Hygiene, Commonwealth of Pennsylvania. A portion of the fluid and part of the cavity wall were sent to Dr. Leroy U. Gardner, Director, Saranac Laboratory for the Study of Tuberculosis of the Edward L. Trudeau Foundation, Saranac Lake, New York.

Report of Dr. William B. Fulton on Fluid: Petrographic analysis failed to reveal any evidence of silica. The ash had the appearance of amorphous mineral matter in which no silica particles could be recognized. Chemical analysis, using hydrofluoric acid, confirmed the absence of silica.

The original specimen was divided and placed into two crucibles and the material ashed at a temperature exceeding 850° C. The amount of ash retained was 5.68 per cent and 4.87 per cent of the original weight in the respective crucibles. Thus, in the whole specimen there was approximately 95 per cent loss of weight. This is consistent with findings observed in individuals whose exposure is limited to ordinary atmospheric dusts.

I would like to mention an observation which probably has little significance, but it is a matter of interest. Under the petrographic microscope, the outlines of tissue cells were clearly seen; both endothelial and columnar types were present and in many instances they retained a nuclear outline. Realizing that all organic material had been burned, the only possible explanation is that the mineral deposits in the cells retained their original shapes after burning.

Numerous smears were examined for tubercle bacilli but none were found.

Report of Dr. Leroy U. Gardner on Fluid and Tissue Analysis: Petrographic and roentgen-ray diffraction analysis of the foul smelling cavity fluid failed to demonstrate free silica, thus confirming the findings of Dr. Fulton. However, by a combination of chemical and roentgen-ray diffraction analyses it was found after incineration that the cavity wall and surrounding tissue showed quartz in a proportion of 0.25 per cent of the dried tissue. This finding is consistent with a diagnosis of silicosis since in other cases the figures for free silica varied from 0.10 to 1.90 per cent.

Microscopic sections revealed conglomerate and discrete hyaline fibrosis with extremely heavy coal pigmentation. Associated with the conglomerate lesion was the usual advanced endarteritis seen near such lesions. The wall of what appears to be an anemic cavity is included; no trace of infection, tuberculous or otherwise, could be discovered. One section of lymph node contained a single discrete hyaline silicotic nodule. The sections confirmed the diagnosis of anthracosilicosis, conglomeration and a cavity apparently due to anemic necrosis secondary to vascular sclerosis.

Comment. In presenting this case it is not my purpose to prove or disprove any of the theories used to explain the mechanism of necrosis and cavitation in the conglomerate lesions of anthracosilicosis although I believe it was anemic necrosis. It was intended only to show that correct interpretation of the roentgen appearance of these lesions may be very difficult.

SUMMARY

1. A case is reported in which liquefaction necrosis occurred in large conglomerate lesions of anthracosilicosis not complicated with tuberculosis. This produced cavities filled with thick, viscid, black fluid.

2. The only known exposure to silica was when the man worked as a pick miner in a soft coal mine for a period of twelve years and there was no exposure for a period of forty-four years before his death.

3. The roentgenologic appearance of the necrotic areas was that of consolidation or pleural thickening.

4. At autopsy each cavity was found to be filled with thick, black, viscid fluid.

5. Examination of the cavity fluid showed no free silica.

6. Examination of the cavity wall and surrounding lung tissue showed a content of 0.25 per cent silica.

7. There was no evidence of tuberculosis.

8. The lungs showed no metastasis from the gastric cancer which caused the death of the patient.

"MITRALIZATION" OF THE CARDIOVASCULAR SILHOUETTE IN THE POSTEROANTERIOR ROENTGENOGRAM*

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AN EVALUATION of the cardiovascular silhouette from one posteroanterior roentgenogram alone is difficult and frequently misleading. Oblique views are an absolute necessity. However, there are many instances when the roentgenologist has available for study a posteroanterior roentgenogram only, and it is for these cases especially that this paper is written.

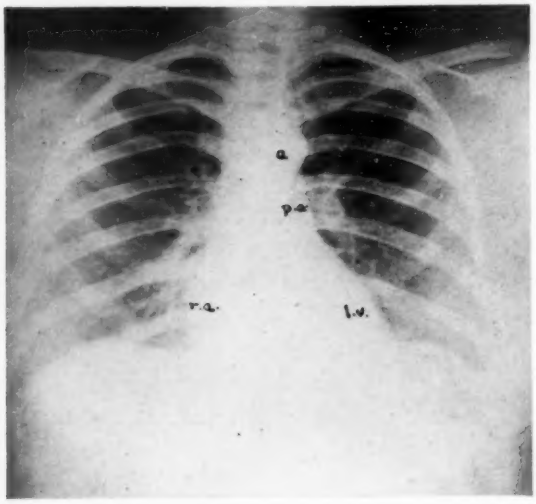

FIG. 1. Normal heart with concavity at the base between the pulmonary artery and the left ventricle. *r.a.* = right auricle; *l.v.* = left ventricle; *a* = arch of aorta; *p.a.* = pulmonary artery.

The term "mitralization," as applied to the cardiovascular silhouette in the posteroanterior projection, has been widely used to indicate a straightening or convexity of the left upper heart border. The exact origin of this term is somewhat shrouded in obscurity, though it was probably first employed by the roentgenologists of the Viennese school early in the Twentieth Century.[33] It is not difficult to imagine that these investigators, observing certain configurations in association with various cardiac valvular lesions, soon came to use such expressions as "mitral type heart," "aortic type heart," "mitralization," "mitral configuration," etc. It then became convenient to utilize these terms, in a more general sense, to describe the roentgen appearance of any heart.

Normally, there is a concavity at the base of the heart between the pulmonary artery and the left ventricle (Fig. 1). In mitral stenosis, however, this concavity is filled in by an enlarged right ventricle, and consequently the left heart border becomes straight or even convex. As the right ventricle enlarges, it can only extend craniad (upward) and toward the left. Expansion ventrad (anteriorly) is limited by the sternum, caudad (below) by the diaphragm, and to the right by the right atrium. During the process of enlargement of the right ventricle, its outflow tract, also designated as conus, becomes prominent, and displaces the pulmonary artery craniad and toward the left. It is the displaced and dilated conus of the right ventricle, and pulmonary artery which obliterate the cardiovascular angle at the base of the heart and give the latter its characteristic appearance in mitral stenosis. This appearance, however, is not confined to mitral stenosis alone. Numerous other conditions, to be described below, may produce a similar configuration.

In the majority of instances, enlargement of the left auricular appendage does not seem to play an important rôle in the formation of the left upper heart border,[20,21,22,26,35] and actual enlargement of the left atrium proper to the left is a rarity.[32]

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I. Physiological

A. Effect of Respiration

Roentgenograms taken in deep inspiration produce a pseudo-straightening of the left heart border because of the descent of the diaphragm. As far as an evaluation of the cardiovascular silhouette is concerned, roentgenograms should be taken under more physiologic conditions, i.e., at the end of quiet expiration (Fig. 2 and 3).

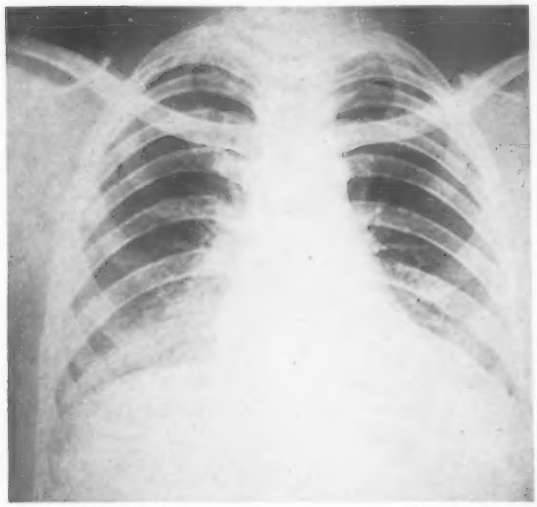

Fig. 2. Normal heart at the end of quiet expiration.

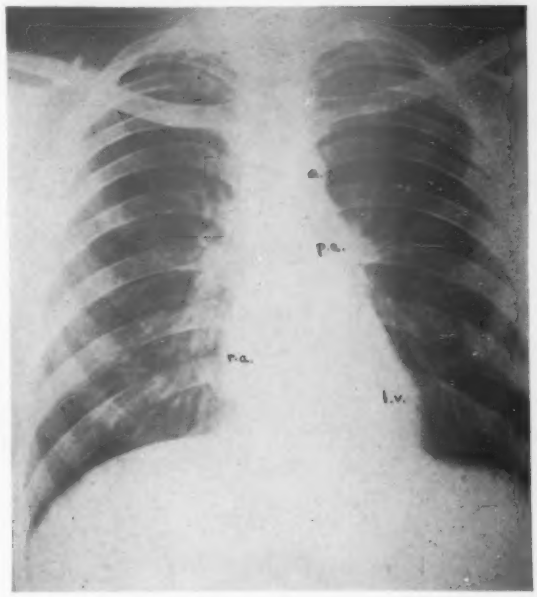

Fig. 3. Normal heart at the end of deep inspiration showing descent of the diaphragm and straightening of the left upper heart border (same case as shown in Fig. 2).

B. Rotation

In the thin, asthenic type of individual with a long, narrow chest and low diaphragm, the heart may rotate in a clockwise direction so that the pulmonary artery is brought into more prominent relief. In addition, the left lower heart border takes a steeper course. This results in straightening of the left heart border, though there is no actual enlargement of any of the chambers or vessels of the heart (Fig. 4).

C. Normal Children

In many children, the heart is globular, the left border being smoothly convex, giving the appearance of a "mitral configuration."[4,10,27,38] One should therefor be particularly hesitant about making a diagnosis of a mitral valvular lesion in children from the posteroanterior roentgenogram alone (Fig. 5).

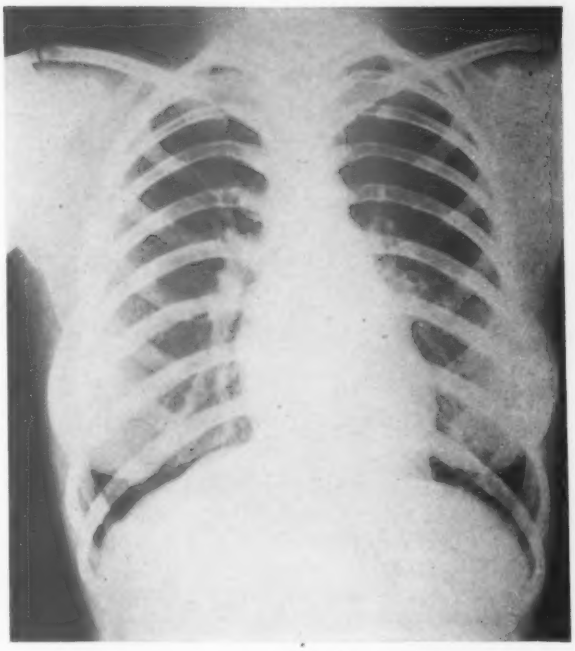

Fig. 4. Heart in asthenic individual with low diaphragm, permitting rotation of the heart's axis and increased prominence of the pulmonary artery.

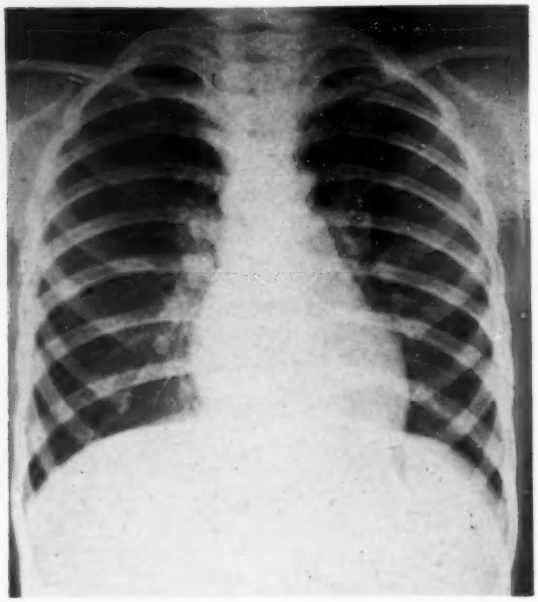

Fig. 5. Normal globular heart found in many children.

D. The Heart with a Prominent, Visible Descending Thoracic Aorta

On a rather casual inspection of the cardiovascular silhouette, particularly if roentgenoscopy is done without adequate dark adaptation, and the film of the heart is underexposed, differentiation within the silhouette may be impossible. In these instances, the outline of the descending aorta frequently cannot be delineated from the cardiac shadow. Hence, the descending aorta produces an accentuated left upper heart border which may result in a so-called "mitral type heart."

II. Pathological

A. Skeletal

1. Right lateral curvature

Scoliosis of the spinal column to the right may cause straightening of the upper left heart border.[5,16] This is due to the fact that, in attempting to accommodate itself to the altered structural changes in the thorax, the heart rotates, bringing the pulmonary artery into more prominent relief. Also, in these cases, a greater portion of the right ventricle enters into the formation of the left heart border (Fig. 6).

In addition, a scoliosis of severe degree can produce a marked alteration in the pulmonary circulation, eventuating in right-sided cardiac hypertrophy and dilatation.[6] These factors also contribute to a "mitral configuration" of the cardiovascular silhouette.

2. Funnel breast (pectus excavatum)

This congenital anomaly results in a varying degree of diminution of the anteroposterior diameter of the thoracic cage. Since the heart has no room to expand in this direction, it does so in the lateral diameter, producing a "mitral type" of cardiovascular silhouette due to the broadening and straightening of the left border of the heart, as well as the right.[13]

B. Pulmonary Disease

1. Chronic cor pulmonale

Chronic, diffuse pulmonary disease can bring about enlargement of the right side of the heart. This enlargement is probably chiefly due to increased resistance in the pulmonary circulation, in conjunction with interference with the respiratory mech-

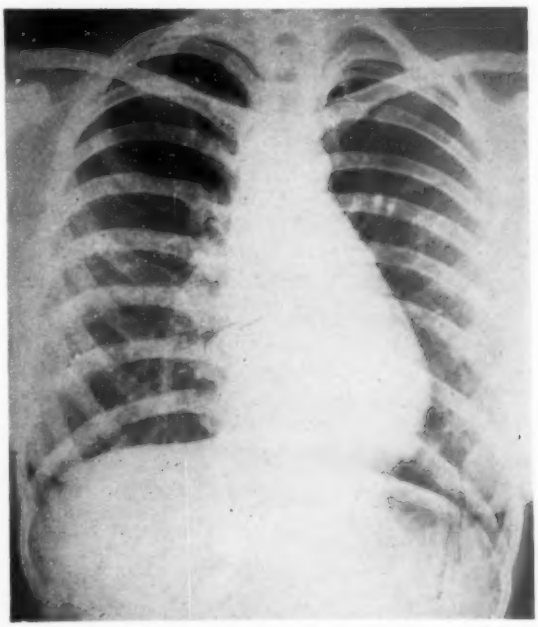

Fig. 6. Right lateral curvature of spine with straightening of the left upper heart border. The second rib on the left is bifid, an incidental congenital anomaly.

anism.[15,19,35] The resulting right ventricular hypertrophy and dilatation of the pulmonary artery may lead to straightening of the left upper border of the heart, giving the so-called "mitral type heart" (Fig. 7).

The following pulmonary conditions can eventuate in such a cardiac silhouette:

a. Pneumoconiosis
b. Emphysema (with or without bronchial asthma)
c. Certain cases of chronic pulmonary tuberculosis
d. Pulmonary arteriolar sclerosis
e. Non-tuberculous bacterial disease —e.g., chronic Friedländer's bacillus infection.

2. Enlarged hilar nodes on the left side producing a large left root shadow, may occasionally simulate a pronounced pulmonary artery and lead to some straightening of the left upper heart border with a "mitralization" pattern.
3. Pleuropericardial adhesions of the left lung with some retraction of the heart to the involved side may cause a straightening of the left upper heart border.

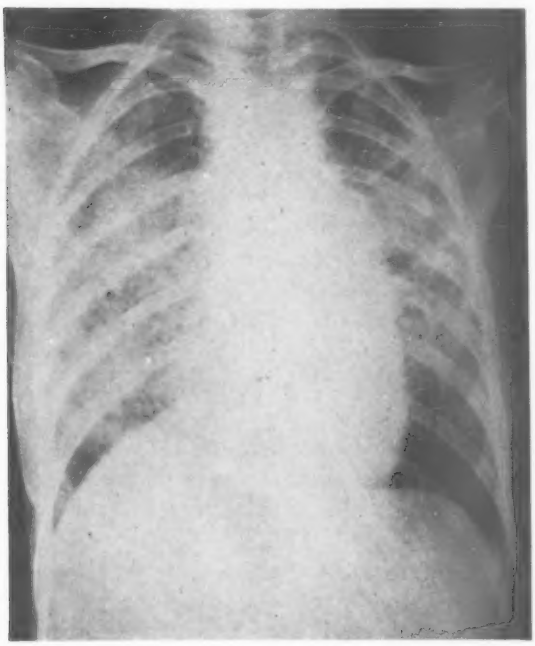

Fig. 7. Chronic cor pulmonale due to advanced silicosis.

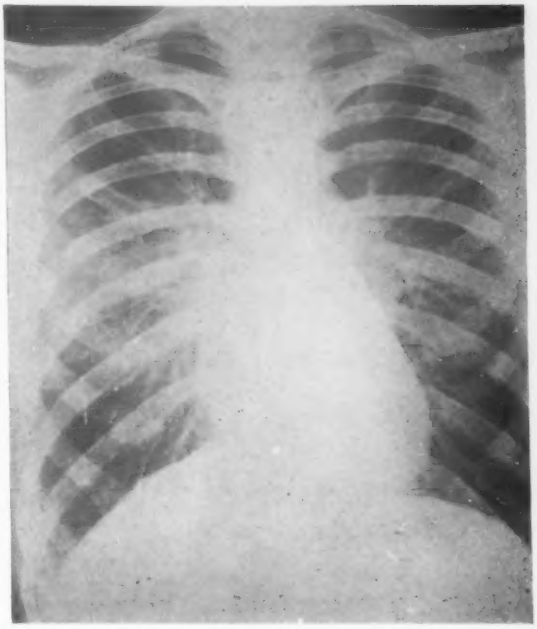

Fig. 8. Heart in thyrotoxicosis with so-called "mitralization."

C. Metabolic and Endocrine Diseases

1. Beriberi

It has been shown that beriberi, a disease due to a vitamin B deficiency, can cause hydropic degeneration of the heart muscle, especially of the myocardium of the right ventricle, with cardiac dilatation and failure.[41,42] The enlargement of the right ventricle and pulmonary artery and the generalized cardiac dilatation associated with heart failure, may result in a so-called "mitral type heart."

2. Hyperthyroidism

In thyrotoxicosis there may be considerable prominence of the outflow tract of the right ventricle and also of the pulmonary artery, due to the great increase in the lesser circulation.[3,42] This may result in a cardiovascular silhouette of the "mitral type" (Fig. 8).

D. Cardiac Disease

1. Congenital

a. Pulmonary stenosis

This congenital anomaly is rarely found as an isolated variety. It is usually associated with a septal defect of some type. How-

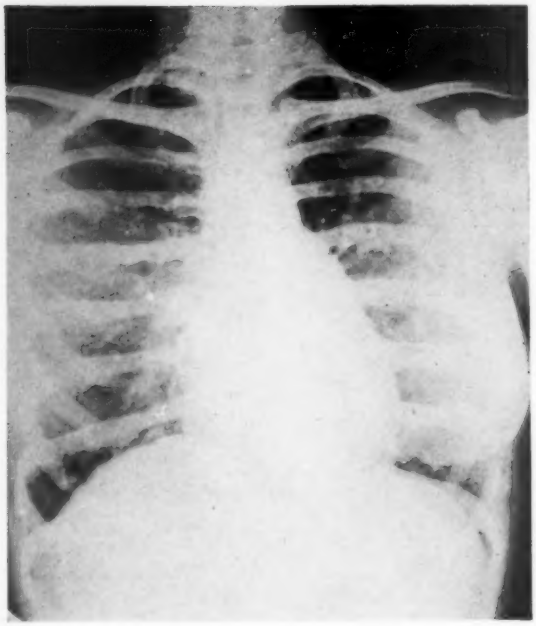

Fig. 9. Patent ductus arteriosus (proved at necropsy).

ever, when it does occur as a solitary lesion, it can lead to right-sided cardiac hypertrophy and a so-called "mitral silhouette" in those instances in which the pulmonary artery is relatively enlarged.

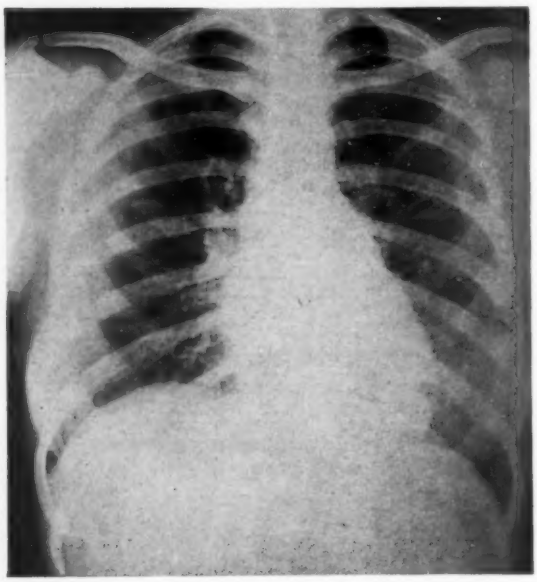

Fig. 10. Heart in a patient with definite rheumatic history and classical signs of mitral stenosis and insufficiency.

b. Patent ductus arteriosus

Patency of the ductus arteriosus may give rise to enlargement of the pulmonary artery and generalized cardiac enlargement with straightening or convexity of the left upper heart border (Fig. 9).

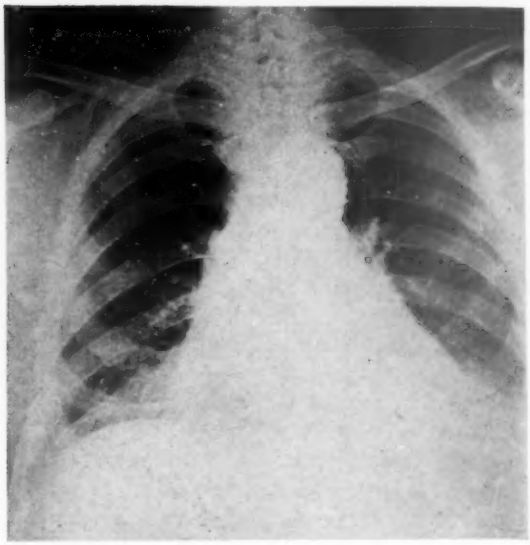

Fig. 11. Globular heart of non-rheumatic patient in cardiac failure.

2. Rheumatic

a. Mitral stenosis

The mechanism whereby this lesion tends to cause obliteration of the cardiovascular angle has already been discussed. Suffice it to say that mitral stenosis is by far the most common pathological condition responsible for a cardiovascular silhouette with a straight left upper border (Fig. 10).[1,2,8,11,12,17,25,31,39]

2. Heart failure

Cardiac failure of different etiologies, with dilatation of all the chambers of the heart and great vessels, can also produce a "mitral type" of cardiovascular silhouette in the absence of actual mitral valvular disease (Fig. 11). Hence, in the presence of heart failure, one must be cautious about diagnosing a mitral lesion roentgenologically.

4. Pericardial effusion

A pericardial effusion, regardless of the etiology, gives rise to a globular heart of the so-called "mitral configuration." Without roentgenoscopic examination and roentgenograms made in both the prone and upright positions, the roentgen differentiation of a pericardial effusion from an advanced mitral valvular lesion may be impossible (Fig. 12 and 13).

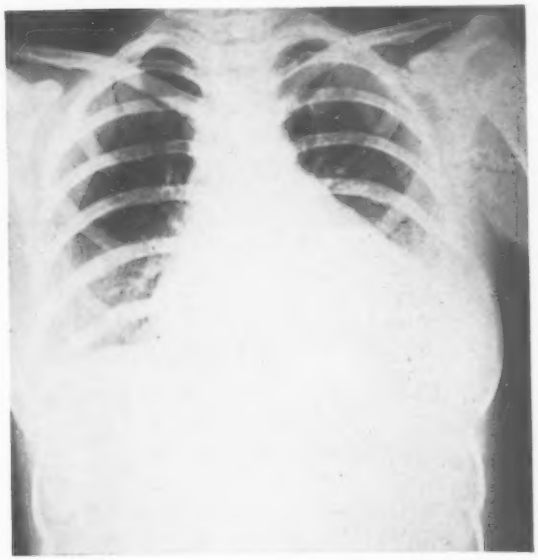

Fig. 12. Upright position. Globular heart due to pericardial effusion in a patient with Libman-Sacks disease and no mitral valvular involvement (proved at necropsy).

Fig. 13. Prone position (same patient as shown in Fig. 12).

It can readily be seen that a variety of heterogeneous conditions, both cardiac and non-cardiac, may produce so-called "mitralization" of the cardiovascular silhouette in the posteroanterior view. Therefore, a roentgenologic diagnosis of mitral stenosis should rarely be made from this view alone; one should also have oblique views, especially the right anterior oblique view with barium paste in the esophagus to demonstrate the presence of left atrial enlargement (Fig. 14). The finding of left atrial enlargement tends to favor the diagnosis of mitral stenosis but may also occur in other conditions such as failure of the left ventricle (of whatever etiology), patent ductus arteriosus, etc.[3]

Fig. 14. Right anterior oblique view with barium paste in esophagus showing displacement and compression of the esophagus in a patient with mitral stenosis. *l.a.* = left auricle.

This paper does not enter into an evaluation of the lung fields, which study must not be neglected since it aids materially

in a differential diagnosis. The appearance of the right hilum, for example, is different in a patient who has a "mitral configuration" because of mitral valvular disease, because of a chest deformity, or because of a marked increase in pressure in the lesser circulation.

Finally, it would be well to discard such equivocal terms as "mitral type heart," "mitralization," and "mitral configuration," since they only lead to confusion. Many physicians, reading the roentgenologist's report of a "mitral type heart" or "mitralization of the heart," falsely conclude that the patient has mitral valvular disease, when actually there may be a cardiac lesion unrelated to the mitral orifice, or no organic cardiac lesion at all. The roentgenologist, therefore, would do well to report the shape of the heart in descriptive terms, and not in ambiguous pathological parlance which can be, and often is, misinterpreted.

SUMMARY AND CONCLUSIONS

1. The term "mitralization," as applied to the cardiovascular silhouette in the posteroanterior roentgenogram, is used to signify a straightening or convexity of the left upper heart border.
2. The so-called "mitral type" heart may be produced by many different factors or conditions, and is not pathognomonic of a mitral valvular lesion.
3. The roentgenologic diagnosis of mitral stenosis should not be made from a posteroanterior roentgenogram alone. Oblique views, especially the right anterior oblique view with barium paste in the esophagus, should be taken to demonstrate the presence of left atrial enlargement. The finding of left atrial enlargement tends to favor a diagnosis of mitral valvular disease, although such enlargement may also occur in other cardiac lesions.
4. The roentgenologist should discard such ambiguous terms as "mitralization," "mitral type heart," "mitral configuration," etc., since they only tend to be confusing and inaccurate.

I am deeply indebted to Dr. Hugo Roesler for his numerous suggestions and reading of the manuscript, and to Miss Annabelle Cooper and Miss Augusta Reitman for the preparation of the illustrations.

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ESOPHAGEAL EROSION FROM POTT'S ABSCESS

REPORT OF A CASE

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THIS sixteen year old colored schoolboy was admitted to Undercliff Sanatorium with a chief complaint of a large, fluctuant mass over his left ribs which had developed within the past month. His father had died of shock two years previously, his mother was then hospitalized with a diagnosis of cancer (site not reported), two sisters had died of tuberculosis many years before, one from pulmonary involvement, the other following tuberculosis of the hip. A third sister was then in another sanatorium with tuberculosis and a brother had drowned. Nine siblings were reported alive and well.

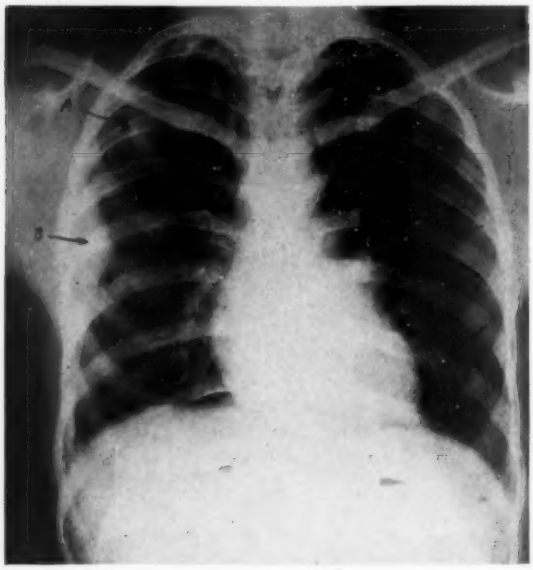

FIG. 1

Because of his heavy exposure to tuberculosis he had been followed in his city clinic and roentgenograms of his chest taken a year before had been suspicious but those taken a month prior to admission showed a definite lesion. Because of this pulmonary lesion and the abscess over his chest wall, he was admitted for care.

On admission he was not acutely ill, was 10 per cent below average weight, was well oriented and cooperative. The only positive finding in his physical examination was the above mentioned mass which was fluctuant but not tender nor reddened and extended from just below the inferior angle of the scapula to the lower left rib border.

Laboratory studies revealed 4,340,000 erythrocytes, 6,700 leukocytes and 80 per cent hemoglobin, with a differential leukocyte count as follows: mature polymorphonuclears, 49 per cent; immature, 6 per cent; eosinophiles, 1 per cent; basophiles, 1 per cent; lymphocytes, 33 per cent; monocytes, 10 per cent. Urinalysis was negative, no sputum could be obtained, blood sedimentation rate was 48 per cent (24 mm. Cutler), there was a two plus reaction to 0.1 mg. of Old Tuberculin in twenty-four and forty-eight hours, the Wassermann and Kahn reactions were negative.

His admission chest roentgenogram is shown in Figure 1 and reveals small infiltrates behind the second and third right anterior ribs with an area of heavy homogeneous density on the lateral chest wall which was interpreted as encapsulated fluid. Diagnoses of secondary pul-

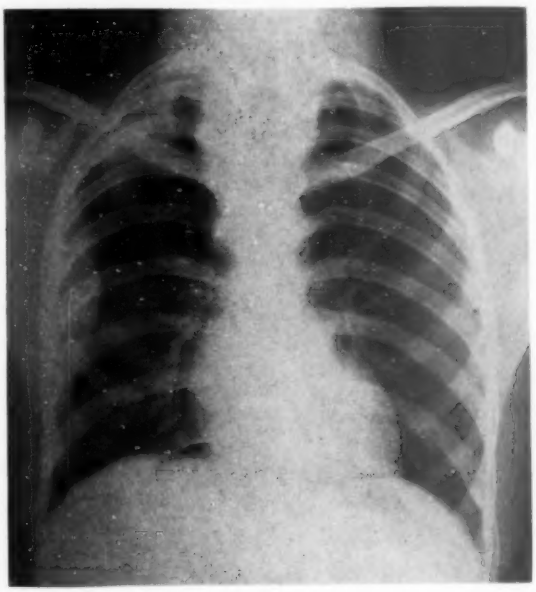

FIG. 2

monary tuberculosis, tuberculous abscess of the chest wall, and encapsulated pleural effusion were made and a poor prognosis given. Treatment outlined was bed rest and aspiration of the cold abscess as needed.

His stay in the hospital was one of protracted, progressive failure—fifteen months in all. The abscess was aspirated six times, yielding an average of 130 cc. of thick, greenish purulent fluid which showed tubercle bacilli in pure culture but not on direct smear. At the end of two months the abscess broke down and drained until the time of his death.

A roentgenogram taken one month after his admission showed a slight extension of his infiltrative lesions but it was noted at that time that the ribs showed no apparent abnormality. He became irregularly febrile (99 to 101° F.) and developed a second cold abscess in the posterior axillary line over the right seventh and eighth ribs. This appeared about three months after admission and was aspirated five times, yielding an average of 50 cc. of reddish, purulent material which also showed tubercle bacilli in pure culture. Two months after the appearance of this abscess it broke down and drained likewise.

A routine roentgenogram taken nine months after admission showed a heavy shadow of homogeneous density similar to the first two but located over the upper central mediastinum (Fig. 2). The patient continued to be comfortable, with a good appetite and few complaints though he was usually febrile and had lost several pounds in weight.

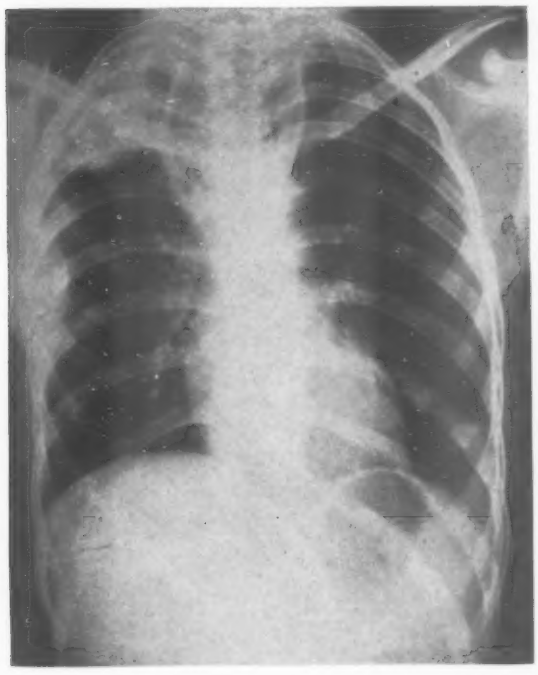

Fig. 3

Fig. 4

The roentgenogram of the chest shown in Figure 3 was taken a year after admission, three months after that shown in Figure 2. As can readily be seen the mediastinal shadow now appears to be air-containing with a thick fibrous wall. Nothing unusual had occurred in the patient's course and the change was unexplained.

From this time until his death fifteen months after admission, he was continuously febrile but considering his toxicity his course was not remarkable. His appetite continued fair and he rarely had complaints of any kind. His death was likewise without unusual incident except for a deepening lack of interest and increased drowsiness. No draining sinuses or superficial abscesses other than the two above mentioned had developed.

A postmortem examination revealed miliary tuberculosis caused by the rupture of fibrocaseous pulmonary abscess into the pulmonary vein, tuberculosis of the ribs of the upper right chest, tuberculosis of the lower cervical and upper dorsal vertebral bodies with a cold abscess which had eroded into the esophagus, and tuberculosis of the ilium and colon.

The failure of appearance of any peripherally draining sinuses which might have emptied the pockets of empyema from the diseased ribs, the absence of kyphosis, the absence of discomfort in spine and ribs, the absence of gastric complaints or vomiting of purulent material, all combined to make diagnosis difficult. In Figure 4 is shown a posterior view of the lungs, mediastinum, and parts of the vertebrae with an arrow pointing to the sinus caused by erosion into the esophagus.

ANOMALY OF THE CERVICAL AND UPPER DORSAL VERTEBRAE (KLIPPEL-FEIL SYNDROME)

REPORT OF TWO CASES

By JESSIE B. HUDSON, M.D., M.S.*
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CASE I. W. B., aged forty-five, a single, white, French laborer, born in Massachusetts. Attended school until he was fifteen after which he worked in the mills. He was a man of good habits and never had any severe illness until the onset of his mental trouble in 1923. At that time he complained of not feeling well, gave up work, and finally developed such marked paranoid ideas that he was sent to the State Hospital for Mental Diseases. The diagnosis was paranoid schizophrenia. The family history was negative except that an aunt had mental trouble.

FIG. 1. Case I.

The patient is an adult male of small stature, with an extremely short, thick neck. The hair line is very low, and there is greatly diminished motility of the head (Fig. 1).

Roentgen Examination. From the fifth dorsal vertebra up, the spine broadens out laterally. The lateral view does not show a broadening of the cervical spine as was shown anteroposteriorly. The bones are fused into a conglomerate mass and no definite landmarks can be located. Beginning at about the fifth dorsal vertebra there is a spina bifida extending upwards. It is impossible to give the location of the upper limit (Fig. 2, 3 and 4). On account of the patient's mental condition no roentgenogram could be taken through the mouth to show the upper cervical vertebrae. The chest is narrow at the top, and there is marked kyphosis in the cervicodorsal region. Roentgenograms were taken of the chest and entire spine. He has eleven ribs on each side. The second and third ribs on the right side are fused for a distance of about an inch. There are five lumbar vertebrae. Patient has no neurological signs or symptoms.

CASE II. M. C., single, white, Italian female, aged twenty-five; born in Italy; occupation mill-hand. The mother was illiterate and retarded. The father was a heavy drinker and

* Now at Hampton, Iowa.

Fig. 2. Case 1.

abusive to his family. He was a patient in a mental hospital for six years before his death.

Patient had many friends and felt entirely at ease with them until they began to go out with the boys. Then she began to feel that she was different, and realized how disfiguring her deformity was (Fig. 5). About five years ago she gave up work at the mills, became uncooperative, suspicious and seclusive, and was admitted to this State Hospital the following year. The diagnosis was paranoid schizophrenia. She had compensated for her deformity by developing a psychosis.

Roentgen Examination. There is a broadening out of the spine, both anteroposteriorly and laterally, from the fifth or sixth dorsal up. The

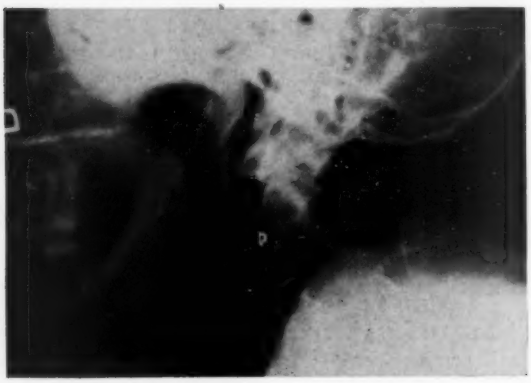

Fig. 3. Case 1.

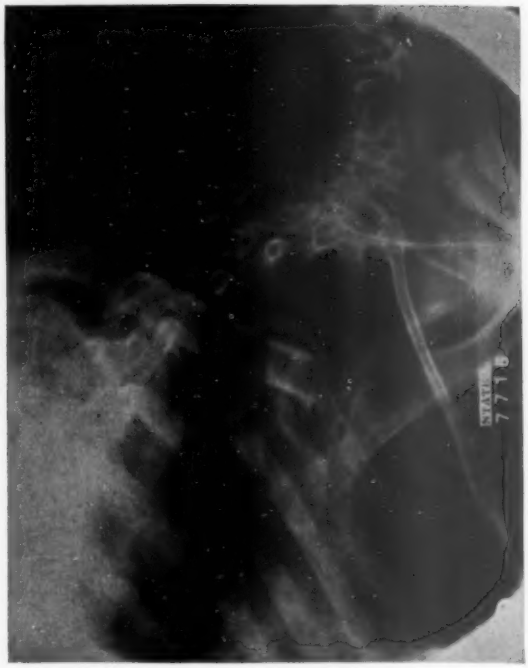

Fig. 4. Case 1.

bones are altered and fused into a conglomerate mass. There are probably several missing cervical vertebrae, but it is impossible to pick out any definite landmarks. She has a spina bifida

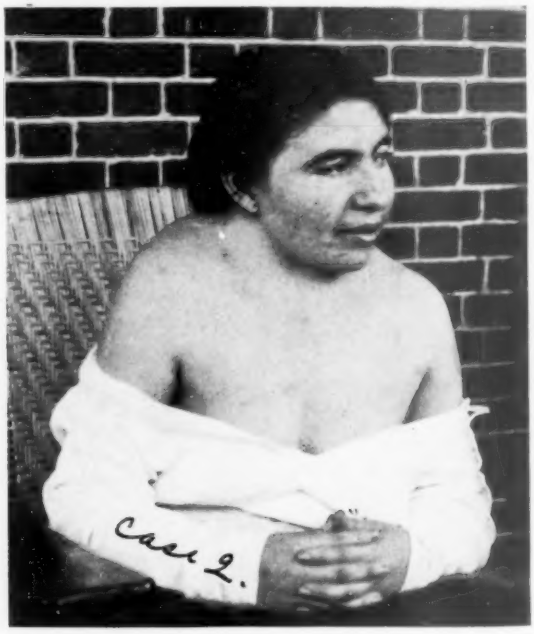

Fig. 5. Case II.

beginning at the level of the fifth dorsal vertebra. It is impossible to determine the upper limit (Fig. 6, 7 and 8). Owing to the mental condition of the patient no roentgenogram could be taken through the mouth to get the upper cervical vertebrae. Roentgenograms of the chest and entire spine were taken. Patient has ten ribs on the right and eleven on the left. She also has a cervical rib on each side. (I consider these as cervical ribs because of the form

Fig. 6. Case II.

and position. The one below these is shaped like a normal first rib.) There are five lumbar vertebrae. A scoliosis is present to the left in the upper dorsal region and to the right in the cervical region. There is no torticollis and no evidence of tuberculosis.

Patient has no neurological signs or symptoms.

This anomaly was described by Klippel and Feil[1,2,3] in 1912. The Klippel-Feil syndrome is a numerical variation in the cervical vertebrae with alteration and more or less complete fusion into one bony mass, often accompanied by spina bifida and other abnormalities. The chief characteristics of this anomaly are: (1) the neck is so short that the thorax almost reaches the

Fig. 7. Case II.

head; (2) the hair line is lowered so that it is on a level with the shoulders; (3) there is limitation of movement of the head.

True torticollis was not present in these 2 cases. In Case II the head is turned to one side and one side of the head is lower than the other, but this is due to the ab-

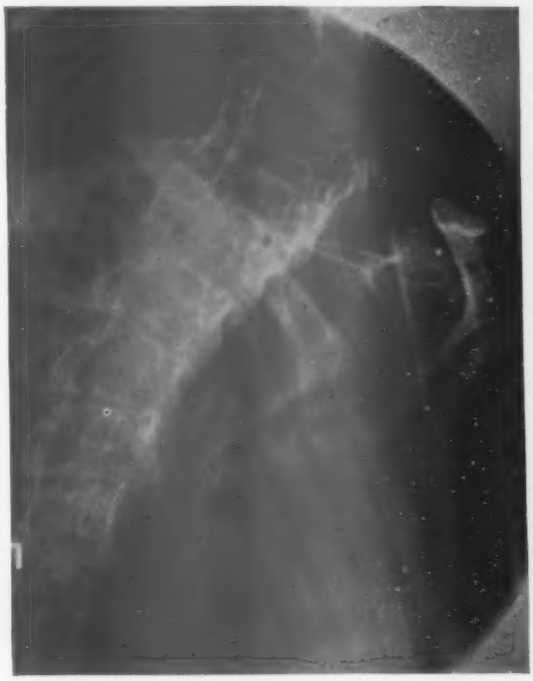

Fig. 8. Case II.

normal development of the vertebrae. The muscles are soft and there is no contraction of the neck muscles. There is a dorsal and a cervical scoliosis in Case II, and marked kyphosis in the cervicodorsal region, especially in Case I.

Many theories as to the cause of this anomaly have been advanced, but the number of cases reported has been so small that no definite conclusions can be arrived at. It is a developmental anomaly and the condition is not benefited by any kind of treatment.

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Vol. 50, No. 1

GARGOYLISM*

REPORT OF THREE PROBABLE CASES

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ALTHOUGH the pediatric literature contains several reports of gargoylism, it is possible that roentgenologists are less aware of this rare, congenital, familial syndrome which produces, among other signs, striking skeletal changes. The purpose of this paper is to report 3 probable cases, emphasizing the roentgenographic features.

Henderson[5] has reviewed the records of 57 reported cases of gargoylism and has added 5 of his own and Ellis[2] has reported an additional case. To them we are indebted for a summary of the characteristic clinical and roentgenological observations. Prior to 1941, the Quarterly Cumulative Index listed gargoylism under "bone atrophy." Since then it has been transferred to "lipochondrodystrophy."

CLINICAL FEATURES OF GARGOYLISM

The term "gargoylism" has been applied as descriptive of the facies and general appearance. The head is usually large and the neck short. The nasal bridge is flat and broad. The lips may be quite thick and partly open due to a protruding, deeply fissured tongue. Dentition may be delayed with the teeth widely spaced and poorly developed. Low-set ears and coarse eyebrows add to the grotesque appearance. In addition to prominent osseous changes, the disease may show many or few of the following features: mental retardation, corneal clouding, and enlargement of the liver and spleen. Although corneal clouding is a prominent feature of those cases reported, it is not always present. The abdomen is protuberant and the liver and spleen are palpable. An umbilical or inguinal hernia is usually found. The appearance of the extremities is fairly characteristic. The legs and arms are relatively short, the joints are held in semiflexion, and complete extension is impossible. The hands are broad and short, and flexion is again seen in the fingers. An equally important abnormality is the lumbodorsal kyphosis which will be mentioned below as a roentgenographic sign. This bend in the baby's back may be the chief reason for bringing it to the doctor. Other clinical features which have been mentioned are mucopurulent rhinorrhea, recurrent otorrhea, deafness, poorly developed muscles, hypertrichosis, retarded sexual development, and leathery skin.

In the differential diagnosis, cretinism and Morquio's disease (osteochondrodystrophy) should be considered. The infants sometimes resemble cretins, but the bone changes do not conform with those of cretinism, and no response occurs to thyroid medication. Morquio's disease offers the greatest problem in differential diagnosis, but mental retardation is not present in this condition, the skull shows no abnormal findings, and the vertebral deformity shows slight differences from that of gargoylism.

ROENTGENOGRAPHIC OBSERVATIONS

Abnormal findings in the skull are constant. The cranium is enlarged and frequently there is hydrocephalus. Abnormal shapes (scaphocephaly, brachycephaly, oxycephaly, etc.) are usually reported. Bony ridges may form along the suture lines. The sella is normal, enlarged, or shallow. Two important findings may be noted in a chest roentgenogram. The ribs may be markedly broadened and the scapulae are often high in position. The spine is involved in a peculiar kyphosis of the dorsolumbar region. The upper lumbar bodies are wedge shaped with the antero-

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FIG. 1. Case 1. Antero-inferior beaking of upper lumbar bodies is demonstrated.

superior portion deficient and the antero-inferior border forming a hook-like process. This kyphosis is, as Ellis, Sheldon and Capon[3] state, the most constant osseous change. If this is observed by the roentgenologist, he would be justified in suggesting the possibility of gargoylism to the clinician. Patients with Morquio's disease may have a kyphosis but this is more gradual and is accompanied by flattened vertebrae.[1] Ellis, Sheldon and Capon also mention slight differences in the scoliosis of these two diseases. Thickened bones are present in the extremities. The humeral and femoral heads may be irregular and flattened with shallow articulating fossae. Irregular epiphyseal ossification may or may not be present. The hands are broad and short with coarsely trabeculated, thickened bones. Retarded carpal ossification is not uncommon.

REPORT OF CASES

CASE 1 (No. 175671). M. D., male, aged three, was first seen in the Pediatric Clinic on March 21, 1941, because of intermittent attacks of diarrhea, and frequent upper respiratory infections. He was the result of a full term pregnancy followed by a spontaneous delivery. Birth weight was 3.8 kilograms. The newborn period was not remarkable. His early development was characterized by a greater than average increase in size, particularly of the head, with some delay in speech development. Although he had no history of serious accidents or illnesses, the mother felt that he was not as "bright" as other children. The mother and two siblings are living and are normal in appearance, but the father has a disproportion of the body similar to that of the patient, the head and shoulders appearing larger than the rest of the body.

Physical Examination. The patient was a white male, three years and three months of age. The following measurements were obtained:

		Normal Range for Age
Weight	20.4 kg.	14.0 kg.
Height	97.0 cm.	91.5–97.5 cm.
Circumference		
Head	53.5 cm.	48.5–50.0 cm.
Chest	62.0 cm.	50.0–51.0 cm.
Abdomen	62.0 cm.	49.0–50.0 cm.
Span	94.0 cm.	88.5–95.5 cm.

He appeared to be quite large for his age and slightly obese, with a disporportionate enlargement of the head, a broad flat nose, wide-set eyes, and a drooling, half-open mouth. The fontanelles were closed. The teeth were normal in number and development. The tonsils were enlarged. The neck seemed very short. The abdomen was protuberant, with the liver and the spleen extending 3.0 to 5.0 cm. below the costal margin. There was some lumbar kyphosis and the legs and arms seemed short, The patient

talked slowly and said very little. He walked without difficulty. Some limitation of extension was present at the elbows. The fingers were broad and slightly curved. The rest of the physical examination showed nothing remarkable.

Laboratory Findings. Urinalysis and examination of the stool (including culture)showed nothing abnormal. The blood count revealed a mild, hypochromic, microcytic anemia with red blood cells of 4.5 million, hemoglobin 11.0 gm., and hematocrit 34.0 per cent. The following blood constituents were measured: sugar 80, non-protein nitrogen 21, calcium 10.9, phosphorus 4.9, cholesterol 204 mg. per 100 cc. The icteric index was 6, and the sedimentation rate was normal. An intracutaneous test with Human Old Tuberculin (1:1000) and the blood Wassermann reaction were negative.

Roentgenographic Findings. A minimal kyphosis is present in the lumbodorsal region (Fig. 1). The most striking observation is the beaking on the antero-inferior borders of the bodies of the second, third and fourth lumbar vertebrae. The chest shows a heart of normal size and clear lung fields. The ribs are exceptionally broad laterally and taper to a normal width near the vertebral column. The skull is not abnormal in shape but is larger than normal. The frontal sinuses are not developed and there is increased density of the lesser wing of the sphenoid and planum sphenoidale. The hand (Fig. 2) taken on April 4, 1941, shows broad, coarsely trabeculated metacarpals and phalanges. Dr. Ramsey reports delay in epiphyseal ossification and carpal maturity according to Todd.[6] A subsequent roentgenogram of the hand taken on January 7, 1942, shows a normal growth of phalangeal epiphyses while the carpal bones are unchanged. The bones of the extremities are large, wide, and thick with relative shortening of the legs and arms. Roentgenographic examination of the father revealed no recognizable changes of similar nature, although he did have large facial bones and nasal accessory sinuses. The ribs were broad and heavy.

Fig. 2. Case 1. Roentgenograms of hand (*A*) April 4, 1941; (*B*) January 7, 1942. The fingers are flexed. The bones are broad and large. The phalanges and metacarpals are coarsely trabeculated.

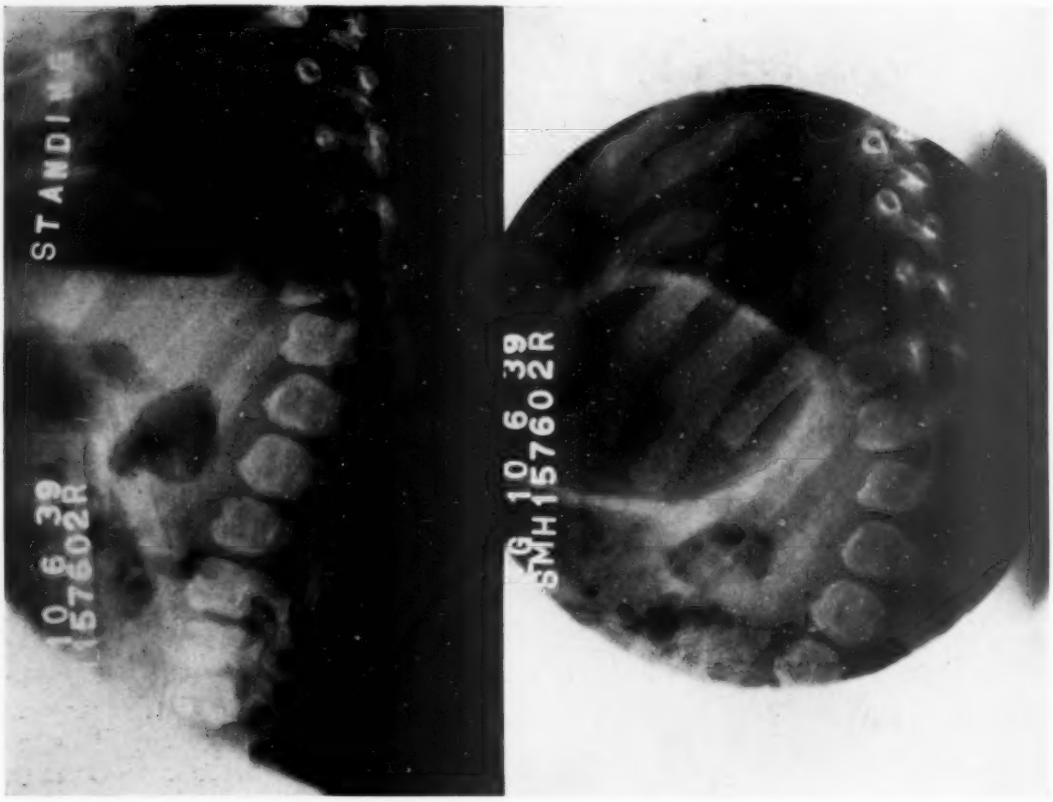

FIG. 3. Case II. Roentgenogram showing lumbodorsal angulation with antero-inferior beaking of bodies.

FIG. 4. Case II. Roentgenogram of chest showing thick, heavy ribs and broad, irregular metaphysis of humeri.

CASE II (No. 157602). J. C., male, was first seen in the Pediatric Clinic on October 6, 1939, at the age of ten months, because of a marked kyphosis and an inguinal hernia. He was the result of a full term pregnancy followed by a prolonged labor, and a forceps delivery. The birth weight was 3.8 kilograms. Considerable deformity of the head and a cephalohematoma were present at birth. His development was normal but the hernia appeared at the age of three months, and the kyphosis was noted when he first sat up. The parents are both living and well but the father had a deformity of the chest similar to that of his child. The brother, aged nine months, is reported as Case III.

Physical Examination. The patient was a large infant with a rather square-shaped head, marked kyphosis of the lumbar spine and a depression of the lower sternum. A large inguinal hernia was present on the right side, but no other abnormalities were noted. His measurements at this time are presented in the following table:

	At 10 Months	*Av. for Age*	*At 26 Months*	*Av. for Age*
Weight	10.3 kg.	9.3 kg.	15.2 kg.	12.2 kg.
Height	80.0 cm.	70.0 cm.	97.0 cm.	85.0 cm.
Circumference				
Head	48.0 cm.	45.0 cm.	53.0 cm.	48.0 cm.
Chest	47.0 cm.	44.0 cm.	52.0 cm.	48.0 cm.
Abdomen	43.0 cm.	45.0 cm.	53.0 cm.	48.0 cm.

Laboratory Findings. The blood Wassermann reaction and intracutaneous tests using Human and Bovine Old Tuberculin (1:1000) were negative. The blood count revealed a mild anemia: red blood cells 4.4 million, hemoglobin 10.8 gm. The blood calcium was 11.5 mg., and the blood phosphorus was 4.1 mg. per 100 cc. Routine examination of the urine and stool showed nothing remarkable.

Roentgenographic Findings. A lumbodorsal kyphosis (Fig. 3) is present. A peculiar beaking is noted at the antero-inferior border of the bodies of the first and second lumbar vertebrae. There is an apparent forward displacement of the twelfth dorsal and first lumbar vertebrae. The chest (Fig. 4) presents broad ribs laterally. The skull (Fig. 5) is large with diastases of the coronal suture. The orbital plates of the frontal bone, when traced forward, slope steeply upward. In the hands the long bones are broad and coarsely trabeculated. There is a delay in epiphyseal ossification and maturity. The pelvis shows a small capital ossification of the right femur.

Fig. 5. Case II. Large skull with diastases of coronal suture.

Fig. 6. Case III. Lumbodorsal kyphosis with slight anterior beaking of the lumbar vertebral bodies and typical broad ribs.

Subsequent Course. The hernia was repaired and orthopedic treatment was instituted at a convalescent hospital. At the age of two years and two months the patient was readmitted to this hospital because of an upper respiratory infection. Additional pertinent findings at this time were protuberance of the abdomen with an enlarged liver and spleen, limitation of extension of the fingers, and evidence of mental retardation. The diagnosis of gargoylism was first made at this time.

Case III (No. 176927). P. C., aged nine months, brother of Case II, was the result of a normal, full term pregnancy. The family doctor and the mother both considered the child to be normal mentally and physically but the doctor states that the head is now larger than normal. This baby has not been studied by the Pediatric Service but we did have the privilege

of a roentgenographic examination. The minimal changes in the dorsal spine suggest that this child at a later age will show the same typical changes as does his brother. The long bones and pelvis are normal in appearance. The skull, except for a definite cuboid shape and large size, is normal. The spine (Fig. 6) presents a lumbodorsal kyphosis with beginning antero-inferior beaking of the bodies, and broad ribs are seen in the lateral view. As in the other cases, the hand shows heavy, coarsely trabeculated bones with heavy irregular metaphyseal bone at the lower end of the radius and ulna.

DISCUSSION

Like most syndromes struggling for recognition, gargoylism is described under a variety of names. Henderson lists the following alternative names: Hurler's syndrome; polydystrophy, Hurler type; chondro-osteodystrophy, Hurler type; dysostosis multiplex, Hurler type; lipochondrodystrophy. The term "gargoylism" is noncommittal in etiological implication, whereas "lipochondrodystrophy" suggests the association of the disease with the lipoidoses (Hand-Christian-Schüller's, Gaucher's, Niemann-Pick's, and Tay-Sachs' disease). The authority for the latter is based on 6 cases discussed by Washington[7] which have been studied at postmortem. On histological examination of these 6 cases the salient feature is the degenerative change in the nerve cells of the central nervous system. The cytoplasmic lipoid deposits found are most pronounced in the basal ganglia and brain stem. Perivascular extracellular lipoid is present as well. This is observed in the gray matter but not in the white. No adequate biochemical analysis of the lipoid material has been made although it is considered to be a cerebroside judging from its staining reaction. Lipoid infiltration is not found in the bones but has been identified in liver, spleen, lymph nodes, lungs, heart, thymus, etc. Engel[4] considers the character of the skin to be an important feature of the disease. On the basis of this and animal experimentation, he proposes the "bleb" theory for the explanation of the deformities. According to his hypothesis, cerebrospinal fluid escapes through a gap in the roof of the developing fourth ventricle and forms blebs in the subcutis of the embryo. If these blebs fail to resorb, they may produce all the defects observed. Engel further states that this theory may well explain the disturbed lipoid metabolism by the effect of bleb formation on the pituitary and hypothalamus. The reader is referred to his original article for further details of this interesting explanation of congenital deformities.

Our patients were large for their age. Although dwarfism is a marked feature in later life, the height is not affected during the first two years of life.[7] Case I presents the unusual finding of a closed anterior fontanelle. The skull, although large, is not abnormal in shape. Case II is more typical, but here, although splenohepatomegaly was present, it was not as pronounced a feature as in Case I. Case III shows changes simulating those of Case II although the baby is too young now for a positive diagnosis. Another year may demonstrate a progressive change.

SUMMARY

Three probable cases of gargoylism are presented, with a brief summary of the characteristic clinical and roentgenological findings.

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DOSAGE SYSTEM FOR ROENTGEN THERAPY

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RADIOLOGISTS have accumulated a vast experience in the response of the visible surfaces to radiation effects. An unfortunate by-product of this is the tendency to estimate total radiation effects in terms of skin response. Along with this is the custom of prescribing dosage to tumors in roentgens measured in air delivered at the surface. This may have been justified due to our early inability to measure accurately the actual dose at points beneath the surface. Indeed it was found convenient to prescribe for deep tumors in terms of erythema at the skin surface. Of late, however, our accurate physical depth measurements, as with phantoms, have tended to make this type of prescription irrational.

For the past few years an effort has been made at the Brooklyn Cancer Institute (under the sponsorship of Dr. William E. Howes, Clinical Director) to prescribe the amount of therapy a given tumor is to receive, rather than to prescribe an amount to the skin. In any case, the number of roentgens delivered into the tumor is calculated in each instance. We wish to present a simple method in use at the Institute, which allows the determination of the tumor dose in terms of roentgens. We will also present a method which determines the amount of roentgen therapy to be given to each portal in order to obtain a prescribed tumor dose.

Our method derives its rationale from the knowledge that within certain limits the dose values obtained at a depth within the body will approximate those obtained with phantom measurements. It has been reported by Quimby and her co-workers that the only appreciable variance is found in the lung and intraoral sites. This has apparently been misinterpreted by some as referring to lung tumors being treated, whereas it refers to normal lung areas adjacent to regions at which radiation is directed. We find that in treating lung tumors there is possibly little variation. Instead of a well aerated lung, we are now dealing with tumefaction, often accompanied by effusion, atelectasis, fibrosis, or adhesions. The density of such a site is at least equivalent to that elsewhere in the mediastinum, or abdomen. Confirmatory indications are noted on a roentgenogram of such a pathologic picture. The density of the tumor shadow often merges imperceptibly with the mediastinal or abdominal shadow. Similarly we feel that in the intraoral site there would be little variation if the ionization measurements were made with the ionization chamber imbedded in the center of the tissue rather than in an open mouth. We therefore use the depth dose figure obtained in phantom measurements for the calculation of tumor dose in any site.

The depth dose measurements we use were made with a special ionization chamber designed for the purpose. The chamber was of the thimble type made of catalin with an outside diameter of 5 mm., the inside surface being coated with aquadag. This small-sized chamber was used in order to reduce any interference of the radiation distribution to a minimum. The wave length independence over the range used was checked and found to be within the experimental error. Measurements were made both in masonite and water and found to be in very close agreement with other recently published figures. It has been further found elsewhere that, with rare exceptions, there is very close agreement with measurements made with cadavers and also in body cavities during treatment. The figures given may be applied where the equipment offers the same quality of radiation or slightly different, without introduc-

TABLE I

SAMPLE DEPTH DOSE TABLE

(200 kv., 2 mm. Cu+1 mm. Al, or 0.4 Sn+0.25 mm. Cu+1 mm. Al; 50 cm. target skin distance)

Depth	Field Area				
	0	6×8 cm.	8×10 cm.	10×15 cm.	20×20 cm.
0 cm.	100	127	133	137	142
0.5	89.5	126	134	139	143
1.0	80.0	122	132	138	144
1.5	71.6	118	127	134	143
2.0	64.0	111	121	127	137
2.5	57.2	104	115	121	128
3.0	51.3	97.5	108	115	125
3.5	46.2	91.5	102	110	121
4.0	41.2	86.6	97.0	104	116
4.5	37.0	82.0	92.3	98.8	112
5.0	33.1	77.7	87.3	94.0	107
5.5	29.8	73.2	82.2	89.0	103
6.0	26.5	69.2	77.0	84.5	98.5
6.5	23.8	64.9	72.5	80.3	94.1
7.0	21.3	60.8	68.4	76.0	90.0
7.5	19.2	56.6	64.1	71.8	85.6
8.0	17.1	52.8	59.3	67.7	81.0
8.5	15.3	48.0	55.1	63.4	76.7
9.0	13.8	43.9	50.8	59.2	72.4
9.5	12.3	40.2	47.0	55.0	67.7
10.0	11.0	35.9	42.6	50.8	63.4
10.5	9.8	33.0	38.7	46.6	59.2
11.0	8.8	29.9	35.9	43.4	54.6
11.5	7.9	27.4	32.6	39.7	50.2
12.0	7.0	25.1	30.2	36.6	46.4
12.5	6.3	22.7	27.5	33.7	42.7
13.0	5.6	20.8	25.1	31.0	39.6
13.5	5.1	18.9	23.3	28.6	36.5
14.0	4.5	17.3	21.5	26.3	33.6
14.5	4.1	16.2	20.2	24.4	31.2
15.0	3.6	15.3	19.0	23.3	29.8
15.5	3.3	14.4	18.2	22.1	28.1
16.0	2.9	13.9	17.3	21.1	26.7
16.5	2.6	13.4	16.5	20.3	25.1
17.0	2.3	12.7	15.8	19.5	24.0
17.5	2.1	12.4	15.2	18.6	23.1
18.0	1.9	11.9	14.5	18.0	22.6

ing any serious error. Where a point under consideration lies off the central point of the surface beam, it is found that the depth may be considered the distance from the central point of the surface field (rather than the normal or perpendicular depth) thereby allowing for the decrease in dosage rate as we depart from the central beam. This will hold to within 1 or 2 cm. from the edge of the beam where a reduction of the scattered radiation still further reduces the dosage rate.

Table 1 is a sample table of our depth dose figures. This is one of a series of depth dose measurements made at the Physics Laboratory of the Department of Hospitals by C. B. Braestrup in conjunction with one of us (I. H. B.). The figures for a zero field

were calculated from the absorption coefficients and are given in order to permit interpolation for fields smaller than 6 × 8 cm.

The fact that we have indicated the values on the table to the nearest tenth of a per cent (of the surface dose) and have given them to the nearest half centimeter of depth may not be justified by either the degree of precision of our measurements or the manner in which the depth of the point under consideration in the body is measured. In doing so, however, we are following the accepted practice of expressing intermediate results involving measured data to one additional place, which is dropped in the final results.

Since the original depth dose figures were prepared there has appeared a set of depth dose figures by Quimby and Laurence,[1] which have been generally accepted as standard. We were gratified to note the close agreement of all our figures with these.

Method for Calculating Tumor Dose When Treatment Factors Are Known. For an accurate estimation of the radiation received in a tumor it is convenient to have a full scale contour of the body at the level of the center of the tumor. This level, except in rare circumstances, also marks the center of the fields of radiation. Various methods for transposing the body contour have been proposed. We have found the use of ordinary commercial wire solder (No. 8 or 10 gauge) to be simple, cheap, accurate and quick. The greatest diameters are checked by calipers. The patient is placed on an examining table in the same position that he will assume when being treated. This is important, as the body contours will often shift with changes in position. The solder wire is bent to the shape of the body at the center level of the area to be treated, and then the shape is transposed to a sheet of paper large enough to hold such an outline. We use sheets of foolscap which, when opened, measure 14 × 17 inches and will take the outline of any transverse body diameter. They may be conveniently folded into the hospital record. By using a large sheet of paper the need for reducing the contour to half the size, as is done in some clinics, is obviated. The location and size of the tumor are now mapped in, and vital structures at the level noted, so that they may be avoided when the treatment is planned. Several authors[2] furnish excellent cross sectional anatomical studies so that it is easy to become acquainted with the structures at the various levels. However, our experience has been that localization of the tumor for proper therapy assumes more importance than the plotting of the neighboring structures, which are usually apparent.

No real difficulty should be encountered in the correct localization of the tumor. The information accumulated during the preliminary study and diagnosis should make this simple. By visualization, palpation, study of the surgeon's report, or viewing the available roentgenograms, localization is accurate. Roentgenoscopy should be used routinely where possible, and in the same position as the treatment will be given, to ensure correct localization. Rarely it may be necessary to check a position by taking a roentgenogram with the beam aimed in the same direction as the anticipated therapy. We have on occasion employed the therapy beam itself to record the beam path on a film. A film is put under the patient and a very short exposure made. The structures are sufficiently recognizable in the resultant roentgenogram to permit the checking of the roentgen beam.

With the location and size of the tumor in relation to the vital structures graphically demonstrated within the contour of the body, the portals for therapy may be chosen and the estimation of tumor dose made with a fair degree of accuracy. The multiple field technique is most appropriate for deep seated lesions. In our clinic the protracted fractional dose method is usually used.

The portals chosen are marked on the contour in the appropriate diameter and the shape and position of the resultant beams are drawn in. The treatments are

given using compression cones of various sizes. The target skin distance likewise is standard, being usually 50 cm. for deep therapy.

Taking the tube target as a point source of the rays, the distance to the skin being 50 cm., and the diameter of the fields known, then the angle of immergence of the outer edges of the beam into the tissues from the surface of the treatment cone can be calculated. The angles are equal to the

TABLE II

ANGLES OF IMMERGENCE OF ROENTGEN BEAM INTO TISSUE FROM TREATMENT CONES

Field Dimension	Immergence Angle Target skin distance = 50 cm.	Immergence Angle Target skin distance = 80 cm.
6 cm.	3° 25′	2° 10′
8 cm.	4° 35′	2° 50′
10 cm.	5° 40′	3° 35′
15 cm.	8° 30′	5° 20′
20 cm.	11° 20′	7° 10′

arc tangent of one-half the projected portal dimension divided by the target skin distance ($\tan^{-1} \frac{1}{2 \times \text{T. S. D.}}$). Table II gives these figures for 50 and 80 cm. target skin distance. This permits the accurate demarcation of the shape of the beam through the tissues. Isodose curves are not drawn into this, but a line is drawn from the center of the field to the center of the tumor or tissue being treated and measured in centimeters. The distance from the center of the skin portal to that point within the beam at which dosage is to be calculated is designated as the *effective depth*. In calculating tumor dosage the distance is taken to the center of the tumor. It is to be noted that this is not the perpendicular distance from the skin to the tissue, which is generally called the depth, but the distance from the center of the skin portal to the point being measured, even though this may follow a diagonal. This distance corresponds approximately to the radius of the desired isodose curve. We use this terminology for convenience, since the depth dose values for the center line of the beam (as is invariably given in tables) may thus be applied to points off the center line. This is justified since the isodose curves within the limits of the direct beam are approximately arcs of circles about the skin portal center for effective depths of over 5 cm. We believe the term *effective depth* (E. D.) is a convenient expression and one which is needed for the implication of a complete sequence of distance and direction from the tube target to the tissue being treated. It is intended that it augment the term target skin distance. No radiologist would feel that the information about therapy were complete without the target skin distance, and from the present discussion it will appear that the effective depth must likewise be stated for a complete understanding and interpretation of the radiation factors. After these lines are drawn and measured, the effective dose for this effective depth is conveniently obtained from the phantom dose chart. The *effective dose* is taken to be the same as the depth dose obtained in the phantom measurements at the same effective depth. The *effective dose* is expressed as the number of roentgens delivered at any point, including the sum of the primary and secondary radiation, per 100 r measured in air at the surface. Any point within the beam may be chosen, and if measured to the center of the skin portal that distance will approximate the corresponding isodose curve lying at the depth. Some danger of error exists when the point is very close to edge of the beam, since a precipitous drop in dosage rate occurs at the edge. When irradiation of such a point is required, it would be better to shift or angulate the beam since the area might otherwise escape the necessary dose. Each of the portals and beam shapes are mapped in, the effective depth measured and the corresponding effective dose charted in a small box at one side of the drawing.

When therapy has been completed, the

total number of roentgens given through each portal is noted and from this the tumor dose is calculated. The collection of such tumor dose statistics and their correlation with the biological effects will furnish invaluable aid in the prescription of correct tumor dosage.

To show how simply this can be calculated, a case of tumor of the kidney will be taken as an example.

Example 1: We are not proposing a method for treating tumors of the kidney but are merely illustrating the manner of tumor dose calculations. After a study of the patient's record and a review of the roentgenograms, a physical examination is made to localize the tumor. After localizing the tumor, the solder wire is molded to the shape of the body at the center level of the tumor and the contour (Fig. 1, *A*) transferred to a large sheet of foolscap.

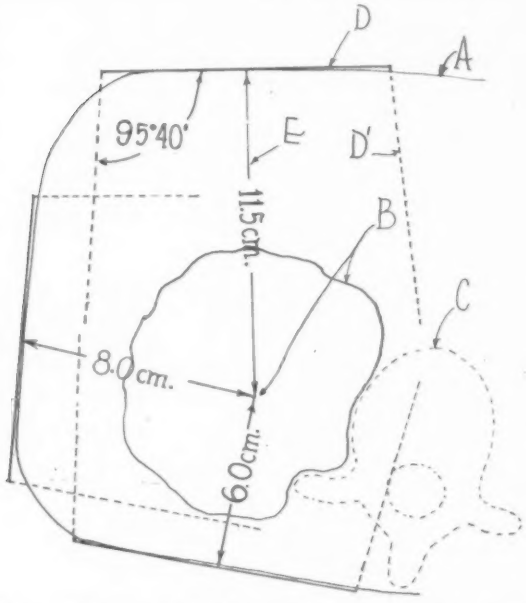

FIG. 1. Tumor dose diagram—Example 1. *A*, exact body contour at the center level of the tumor. *B*, tumor outline and center. *C*, important neighboring structure. *D*, surface fields. *D'*, roentgen beam outline. *E*, effective depth.

Into this contour is drawn an outline of the shape and position of the tumor (Fig. 1, *B*). After some experience it may not be necessary to draw the whole outline of the tumor, but merely to represent its center by a dot. Neighboring vital structures may be designated (Fig. 1, *C*). Of course, all the therapist's experience enters into the decision as to the type of therapy, but a topographical illustration, as shown, is always valuable in determining some of the factors to be used, such as the number and position of the portals. From the drawing it is noted that a three-portal technique might appropriately cross-fire a kidney lesion. Suppose the following factors are used: 200 kv. (peak), 2.0 mm. Cu and 1.0 mm. Al filter, 50 cm. target skin distance, 200 r to three fields daily for a total of 2,000 r to each field.* The appropriate diameters of the chosen fields are then marked on the surface contour in exact size, since the outline is life sized. Thus, if it is decided that three 10×15 cm. fields will be used, one anteriorly, one laterally, and one posteriorly, aimed to cross-fire the lesion, then three 10 cm. fields are indicated on the contour in the exact position as they will be used in the treatment of the patient (Fig. 1, *D*). It will be noted in the figure that the skin lies flat up against the portal. However, the normal contour is irregular and not likely to fit closely to the cone surface. However, with compression, the skin surface can be molded to lie flush with the treatment cone, or it may be built up artificially. Where the surface is actually irregular, how-

* The technique indicated was chosen for clinical rather than physical considerations, it being recognized that the depth dose could be increased somewhat by reducing the filtration and increasing the distance.

Field	Effective Depth cm.	Size Field cm.	Effective Dose. Depth Dose in r per 100 r Given in Air	Total 100 r Given in Air	Total Field Tumor Dose
Anterior	11.5	10×15	39.5	20	790
Lateral	8.0	10×15	68.0	20	1360
Posterior	6.0	10×15	85.0	20	1700
				Total tumor dose	3850 r

ever, or where the cone face is intentionally angulated, simple calculations, based on loss of dosage rate due to increasing distance, may be made. These will be discussed later. The angle of immergence of the beam into the body from a 10 cm. field at 50 cm. target skin distance is found in Table II and is seen to be 5° 40′. The roentgen beam is indicated by two lines (Fig. 1, *D′*), each drawn from the end of the portal line at the proper angulation. This is done quickly with a protractor. Another simple procedure is to cut permanent beam shapes from celluloid and thereafter whenever a particular size of field is used, a line may be drawn around its edge onto the depth dose drawing, thus obviating the need for measuring the beam each time. This has the additional advantage of being able to be used as a beam director. Lines are now drawn from the center of each of the skin portals to the center of the tumor and the corresponding effective depth measured in centimeters (Fig. 1, *E*). The effective dose for each effective distance may be found on the depth dose table (Table I). These are recorded to the closest 0.5 r on the small chart to one side of the drawing. Thus the effective depth for the anterior portal is 11.5 cm. It will be seen from the effective dose chart that at that depth, using a 10×15 cm. field, with those factors, for every 100 r measured in air at the skin, the tumor will receive 39.5 r. If 200 r is given to the skin at each treatment, the tumor will receive 39.5 r×2 or 79.0 r. If a total of 2,000 r is given through that field then the tumor will receive 790 r (39.5 r×20) through the field. The effective depth of the lateral field is 8.0 cm. and its effective dose is 68 r, or stated in a different way, it will receive 68 r at that depth for every 100 r measured in air and delivered to the skin. If a total of 2,000 r is given through this portal then the tumor will receive from it a total of 1,360 r, (68 r×20). The effective depth of the posterior field is 6.0 cm. which is the smallest distance, and it will be noted for this reason that the tumor will receive most radiation from here. The effective dose at that depth for 100 r measured in air and delivered at the surface is 85 r. For a total of 2,000 r given through this field the tumor will receive 1,700 r. By adding the total dose delivered through each field the total tumor dose is obtained. In this case it is 3,850 r.

It is therefore possible to determine with a fair degree of accuracy the amount of radiation the tumor has received from a given course of therapy. It will be seen that although all the external factors may be the same, the varying effective depth will result in marked differences of tumor dosage. Since the body diameters of different individuals and different parts of the body vary, the tumor dosage will likewise vary depending upon the effective depth. It is apparent, therefore, that to give only the external factors of roentgen therapy, without giving the final tumor dose, will not indicate a true picture of the actual treatment. The results of any series cannot be estimated without this information. A thin individual or a child, treated with exactly the same skin dosage as an obese adult, might actually be given two times the amount of delivered tumor radiation. This is one of the reasons why some cases do well with therapy and others do not. It would be impossible, therefore, to make any comparisons on the basis of external dosage, and for the most part meaningless to review results which are not based on tumor dosage.

Calculation of Dosages when Field Cones are not Compressed Against Surface.

In arranging the fields it may be undesirable or impossible to place the cone surface in contact with the skin. When this occurs, corrections must be made in the tumor dose calculation which are based on the loss of dosage rate due to increasing distance. Using the inverse square law the percentage loss due to increased distance may be figured (Table III).

If the target skin distance is increased from 50 cm. to a much greater distance, the depth dose tables given for 50 cm. should be corrected. If, however, the change is not more than a few centimeters, the error introduced is negligible (0.6 per cent in the following example).

Example 2 (Fig. 2): Suppose the anterior cone were placed 1 cm. from the skin surface. A line is drawn from the center of the portal to the center of the tumor. The effective depth would be measured along the line from the skin surface

to the tumor center and the effective dose for that distance found from the depth dose table (Table 1). Since the cone surface is 1 cm. from the skin, the target skin distance is now 51 cm. instead of 50 cm. From Table III we see that there has been a percentage loss of 4 for 1 cm. If the effective dose were 39.5 r the tumor would receive this amount—4 per cent, or 38 r.

Example 3 (Fig. 3): If, instead of the cone being placed evenly at a distance from the skin

TABLE III

TABLE OF CORRECTIONS FOR INCREASED TARGET SKIN DISTANCE

Target Skin Distance cm.	Percentage Decrease in Dosage Rate (From 50 cm. target skin distance)
50.5	2.0
51.0	4.0
51.5	6.0
52.0	7.5
52.5	9.5
53.0	11.0
53.5	12.5
54.0	14.0
54.5	16.0
55.0	17.5

it were angulated with one end touching the skin, then a calculation is made which is based on the average distance the cone is removed from the skin. This is independent of the anticipated skin reaction which is expected to be greatest where the cone is closest to it.

The cone surface is touching the skin at one end and is raised at the other. A line is drawn from the center of the cone to the center of the tumor. The effective depth is measured along this line from the skin to the center of the tumor.

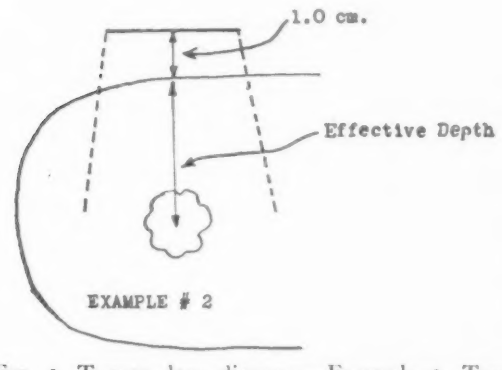

FIG. 2. Tumor dose diagram—Example 2. Treatment cone at a distance from skin surface.

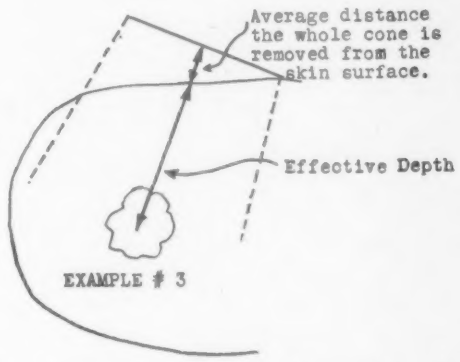

FIG. 3. Tumor dose diagram—Example 3. Treatment cone at an angle to skin surface.

The distance from the center of the cone bottom to the skin is likewise measured along this line and is taken to be the average distance which the whole cone surface is removed from the skin. While this gives only an approximate reduction in dosage rate, it nevertheless is quite useful in estimating loss. If this average distance is 2.0 cm. then the target skin distance becomes 52.0 cm. From Table III it is seen that there is a loss of 7.5 per cent.

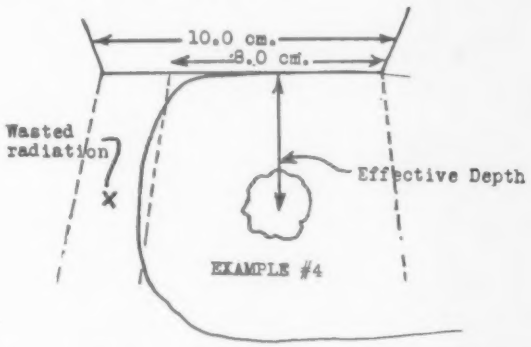

FIG. 4. Tumor dose diagram—Example 4. Treatment cone over edge of skin surface.

Example 4 (Fig. 4): If the cone is so placed that part of its surface lies over the edge of the body surface, and those rays wasted, then the field size is measured only according to the actual body surface being irradiated.

Measurements are all made from the center point of the useful cone surface. On the 10 cm. field illustrated, 2 cm. lies over the edge of the body and gives no useful radiation. The center point used is not 5 cm. from the edge but is

taken to be the center of the useful surface which in this case is 4 cm. from the useful edge, although the original field size was 10×15 cm. The tumor dose is calculated on the basis of an 8×15 cm. field instead of 10×15 cm. The value for 120 sq. cm. can be found from the effective dose tables by interpolation. The amount for any surface area may similarly be obtained by interpolation.

Method for Calculating Amount to be Given to Skin Fields When Dosage to Tumor is Prescribed as Tumor Dose. The prescription of a tumor dose and not skin dosage is the goal toward which we are striving. Coordination of dosage and effects on the tumor itself will give valuable information which we do not yet have. By simple calculations it is possible to prescribe the tumor dose, and then by reversing part of the procedure described in the preceding examples compute the amount to be given to each skin field in order to obtain the given dosage. For instance, instead of prescribing the dosage in terms of skin factors, the order is given as follows: Give 4,000 r to the center of the kidney tumor. The procedure is then to determine how many roentgens must be given to the skin to deliver that amount to the tumor. Of course the radiologist uses all his experience in determining what factors are to be used for a particular depth. For a tumor at a depth it may be decided to use 200 kv. (peak), 2.0 mm. Cu and 1.0 mm. Al filter, 50 cm. target skin distance. The amount of roentgen radiation to be given to each field and the number of fields to be treated vary with the different clinics. The method followed at the Brooklyn Cancer Institute is as follows: A body contour at the center of the level of the tumor is obtained and transferred to a sheet of paper (Fig. 1, *A*). Into this is drawn an outline of the shape and position of the tumor. The center of this is designated as *B'*, neighboring structures are noted (*C*). The therapist's experience then decides how many fields are to be used, and their location and size. From the contour drawn in the example it will be seen that three 10×15 cm. fields may appropriately be used.

It should be stated, however, that the number here is purely arbitrary. Another therapist may desire to use one or two fields only, or possibly a fourth field angulated inward from the other side of the body. The fields chosen are drawn into the picture in their exact size and appropriate diameter. Thus three 10 cm. lines (Fig. 1, *D*) are drawn. The angle of immergence into the body is obtained from Table II (for 10 cm. = 5° 40′) and then the roentgen beam designated by lines drawn from the ends of the field lines (*D'*). Lines are then drawn from the center of each field to the center of the tumor and measured (*E*). This gives the effective depth for each field. We now have the following: Three fields 10×15 cm. in size cross-firing the kidney tumor, using 200 kv. (peak), 200 mm. Cu plus 1.0 mm. Al filter, 50 cm. target skin distance, and the effective depth for each field. A small chart at one side of the drawing is then filled in. The effective dose for each effective depth may then be noted from Table I.

It is seen that the effective depth of the anterior portal is 11.5 cm. The effective dose at that depth designated to the closest 0.5 r is 39.5 r. The effective depth of the lateral field is 8.0 cm. with an effective dose of 68.0 r. The posterior effective depth is 6.0 cm. with an effective dose of 85.0 r.

A cycle of therapy giving 100 r to each of the skin fields will give a tumor dose equivalent to the sum of the effective dose of each field.

Anterior field =	39.5 r
Lateral field =	68.0 r
Posterior field =	85.0 r
	192.5 r

It is desired to give 4,000 r to the center of the tumor as a final total tumor dose. Then the final dose (4,000 r) divided by the sum of the effective doses (192.5) indicates how many times each field is to receive 100 r to give that total. A quick approximate computation comes close to the final figure, thus:

$$
\begin{array}{r}
21 \\
\hline
190/4000 \\
380 \\
\hline
200 \\
190
\end{array}
$$

Check:

$$
\begin{array}{r}
192.5 \\
21 \\
\hline
192.5 \\
3850 \\
\hline
4042.5
\end{array}
$$

It is seen, therefore, that 2,100 r given to each of the fields will give the desired depth dose of approximately 4,000 r (192.5×21 r =4042.5).

	Effective Depth	No. of Applications of 100 r (in air) ×Effective Dose		Total Effective Dose per Field
Anterior field	11.5	39.5×21	=	829.5
Lateral field	8.0	68.0×21	=	1428.0
Posterior field	6.0	85.0×21	=	1785.0
		192.5×21	=	4042.5

This example was calculated so that twenty-one treatments of 100 r each would be given to each field. However, any number of roentgens may be given per day, depending upon the therapist's desires, without disturbing the method of calculation.

It is seen that if the effective dose for each field is known then it is a simple matter to determine how much should be given to each field for a desired tumor dose. The therapist may note that in a thin patient with a narrow part a much smaller dosage is required to the skin than he has been used to giving. He may therefore save the skin from needless exposure. As a corollary to this, he may find that in order to give a desired tumor dose, he would have to exceed what he feels are the limits of skin tolerance. He may add other fields or may realize the impossibility of giving the desired tumor dose through the skin fields. He will then seek accessory methods of therapy such as interstitial irradiation, or recommend that another method be used, such as surgery. In any case, he will not have the false sense of security sometimes obtained when all the skin fields are irradiated to tolerance. Above all, the prescription of tumor dosage may teach us as much about tumor response to therapy as we have learned about skin responses.

SUMMARY

(1) The term "effective depth" represents the distance from the center of the skin field to that point at a depth within the beam at which dosage is to be calculated. "Effective depth" is a necessary and at the same time a convenient designation denoting complete sequence of distance and direction from the target to the depth being treated. It is intended to amplify the term "target skin distance." For a complete understanding of the radiation factors, this must be as constantly specified as the target skin distance.

(2) The "effective" dose is the number of roentgens delivered at any point at a depth within the beam, including the sum of the primary and secondary radiation, per 100 r measured in air at the surface. It is taken to be the same as the depth dose obtained in the phantom measurements at the same depth distance.

(3) A simple method is presented to show how to calculate the tumor dose when the roentgen treatment factors are known.

(4) A simple method is presented to show how to determine the amount of radiation to be given to each field when the tumor dose is prescribed.

(5) We do not claim absolute accuracy for the methods, nor originality, nevertheless we feel that they afford workable approximations and may be used.

(6) The need for a knowledge of the tumor dose in each case is stressed.

(7) We consider the important feature of our method to be its simplicity, proof of which is indicated by the fact that it has been carried out routinely on all roentgen therapy cases for more than five years.

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A SYSTEM OF TUMOR DOSAGE, RECORDS AND TECHNIQUE AS EMPLOYED AT THE BROOKLYN CANCER INSTITUTE*

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SUPERVISION of any radiation service is weighted with grave responsibility both with regard to efficiency, accuracy, adequacy of the treatment given and to the erection of proper safeguards to prevent any serious radiation complication. The larger the service, the more numerous the staff, the greater the danger of some human or technical error and the more necessary standardization and simplification of technique.

This paper is written to describe such administration of a radiation service relative to ordering individual treatments, of summarizing the total dose to the skin and the tumor and of their tabulation and recording. At the Brooklyn Cancer Institute, where approximately 45 patients are treated daily, besides the attending staff, two full-time physicians, three technicians and a physicist are required for the proper functioning of the department.

When a patient with cancer is referred to the radiotherapeutic service, that patient and his record must follow through a definite sequence until his treatments are completed. The radiologist's orders as written must include the nature of the patient's disease, the location of the area to be treated, the size and number of fields and the factors to be used, and finally the tumor dose to be administered. By agreement, no roentgen therapy is instituted until the record of the pathological material is charted. In exceptional cases, the radiologist may specifically authorize a limited number or a complete cycle of treatments without such proof. This check prevents overenthusiastic treatment of some condition on a clinical diagnosis only. Whenever an area is re-irradiated, the therapist ordering the treatment is required to note the condition of the skin and state that in his opinion the skin and deeper tissues will tolerate the additional treatments prescribed.

When a radiologist orders treatment to any lesion, he should not only have a clear concept of the pathologic diagnosis (biopsy) including biological reaction, but he should be able to justify his proposed treatment technique upon a physical basis. A routine cycle for all pelvic cases, irrespective of the size of the pelvis, should therefore never be prescribed. For example, Figures 1 and 2 represent two pelves; the smaller measures 17 cm. in its anteroposterior diameter, the larger, 24 cm. By giving the same surface dose, 2,000 r in air, 2,700 r with backscatter (see Table II), to each of six fields would deliver an estimated 4,800 r to the parametrial zone in the smaller pelvis and but 2,800 r to the same anatomical location in the case of the larger pelvis. This illustrates the marked variation in tumor dose which would result when treatment is ordered with reference to skin tolerance only.

Tumor response, to a great extent, is dependent on the amount of radiation delivered into the depth within a given interval of time.[9] Injury to the skin or surrounding structures is the limiting factor which may prevent delivery of a carcinogenic dose to any stratum. In any summation of radiation treatments it is therefore essential to indicate the so-called "tumor dose" and to state the interval of time during which this was delivered. An efficient system of calculation of skin dose from a predetermined tumor dose, as has been developed at the Brooklyn Cancer

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Institute, is described by Camiel and Blatz.[2]

At the Brooklyn Cancer Institute only seven qualities of radiation are used. These are made up from four types of kilovoltage. The target skin distance is limited to three set measurements. The intensities vary from 13,000 r to 13 r per minute. All qualities are expressed in half-value layer and these half-values have been transposed in 50 per cent depth in water for further clarification.

Quality Determination (Kilovolts and Filters). Before contact roentgen therapy of 45 kv. was available, a setting of 80 kv. without filter at 15 cm. target skin distance with an approximate half-value layer of 0.5 mm. Al was used in the treatment of all superficial lesions. At the present time all such lesions not over 5 cm. in diameter are treated with short target skin distance (1.8 cm.) contact therapy (Braestrup and Blatz[1]).

100 kv., with or without filtration, is used for treatment of superficial lesions larger than 5 cm. in diameter.

135 kv., with filtration of 3 mm. Al, is used in treatment of subcutaneous and superficially infiltrative lesions.

200 kv., with filtration of 0.5 mm. Cu and 2 mm. Cu equivalent, is used in the treatment of all lesions 4 cm. or more below the surface. It is appreciated that the increase from 0.5 mm. Cu to Thoraeus equivalent of 2 mm. Cu cuts the

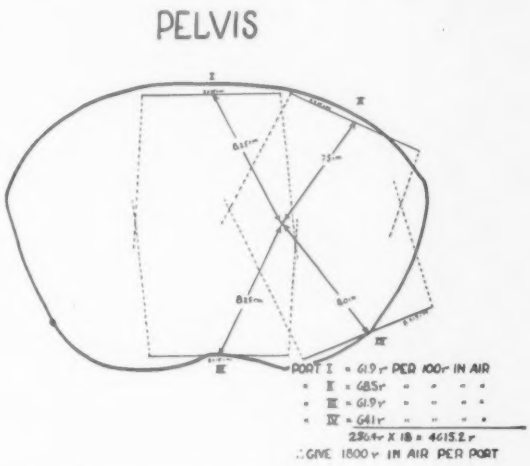

FIG. 1. Cross-section and measurements of pelvis I and method of computing "effective depth" and "tumor dose."

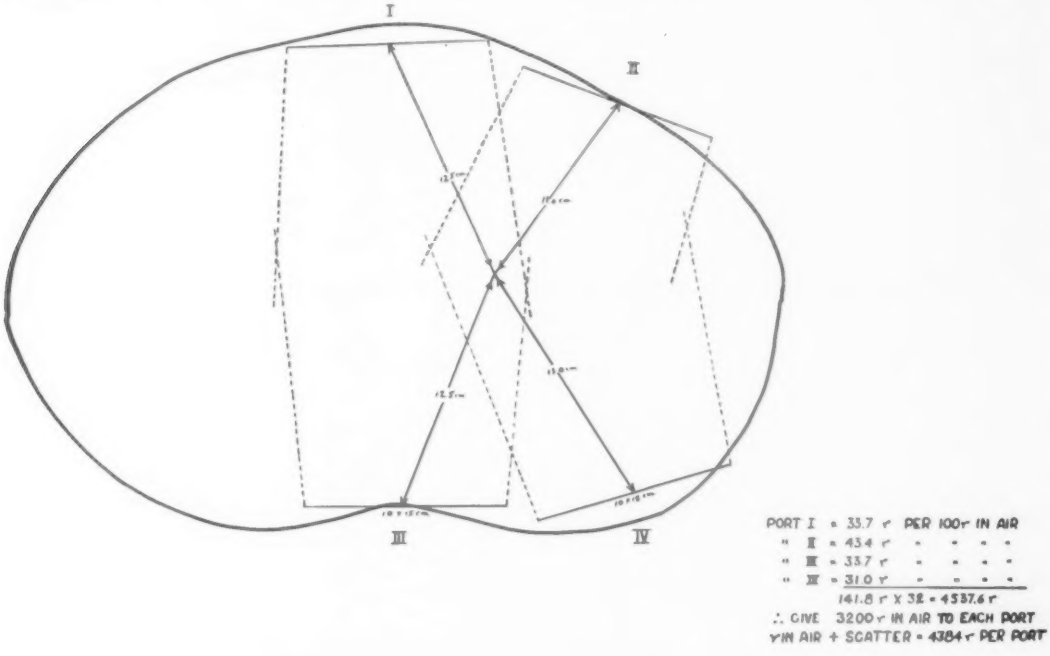
I
II
III
IV
PORT I = 33.7 r PER 100 r IN AIR
" II = 43.4 r " " " "
" III = 33.7 r " " " "
" IV = 31.0 r " " " "
141.8 r X 32 = 4537.6 r
∴ GIVE 3200 r IN AIR TO EACH PORT
r IN AIR + SCATTER = 4384 r PER PORT

FIG. 2. Cross-section and measurements of pelvis II and methods of computing "effective depth" and "tumor dose." Note the difference in roentgens in air per skin field necessary to deliver equal "tumor dose."

intensity of the beam to one-half and only drives the 50 per cent depth (using an identical large field) down 0.7 cm. deeper in water (see Fig. 3). A greater depth dose than that obtained by the use of 0.5 mm. Cu at 50 cm. is desirable for all lesions over 7 cm. in depth. There are 2 methods of increasing this depth value without raising the kilovoltage: (1) increased filter and (2) increased distance. To determine which is better, two conventional techniques

(A) 0.5 mm. Cu, 80 cm. target skin distance, and

(B) 2 mm. Cu equivalent, 50 cm. target skin distance are compared: Investigation of depth dose figures for these two techniques indicates that there is not more than 1 per cent difference up to 15 cm. depth. This has been confirmed using the figures in the Standardization Committee Technical Bulletin No. I.[11] From the standpoint of economy of time, however, it is found that the Thoraeus filter at 50 cm. gives the same dose in a shorter time by about 20 per cent and only 2 to 3 per cent with Cu filtration.

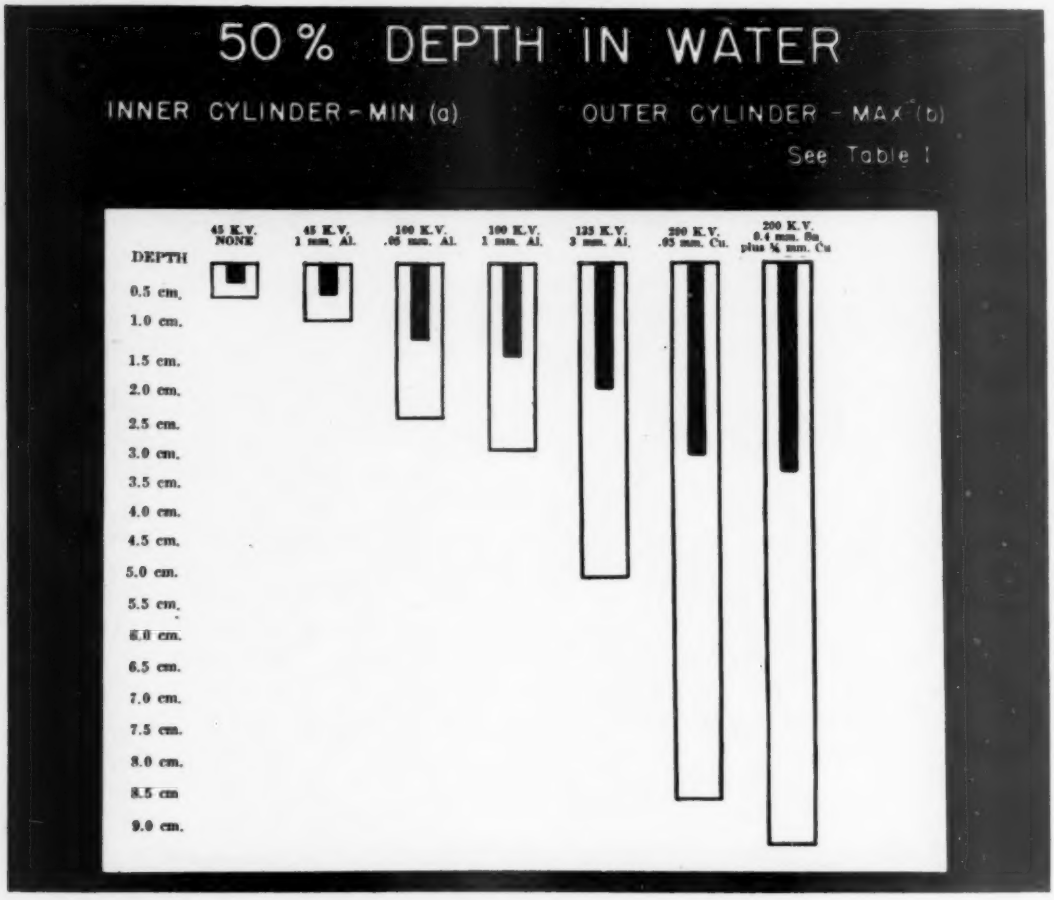

FIG. 3. The depth at which the radiation is reduced to 50 per cent of its surface value. Inner cylinder = theoretical pencil beam without backscatter. Outer cylinder = maximum field size which varies with technique. See (b) under Table 1.

Another advantage in using increased filtration rather than increased distance with lesser filtration is the biological reaction. A greater number of roentgens is needed to produce an erythema with increased filtration. That this is not entirely due to less absorption within the superficial layers is attested to by Failla:[4] ". . . it means that the biological effective-

ness of equal doses of roentgen rays expressed in roentgens is different for different wave lengths." The time interval between the administration of an erythema and its development increases with harder qualities of rays. It is our experience that late changes such as parchment skin with telangiectasia and latent breakdown are less apt to occur with increased infiltration.

With these facts in mind increased filtration has been chosen in preference to increased distance with lesser filtration in the treatment of all deep-seated lesions.

The installation of ionization chambers in each tube head (except the contact apparatus) has added an inherent minimum filtration of 0.5 mm. Al. The half-value layer has been increased thereby to 1 mm. Al on the superficial therapy apparatus. In all other cases the filters have been reduced by the amount of the chamber filtration with no change in the composition of the resultant roentgen-ray beam. Filtration of 2 mm. Cu, or its equivalent, is locked in the tube heads of three of the four deep therapy installations as most treatments with the tumor 4 to 7 cm. in depth and all treatments with the tumor 7 cm. or over below the surface are treated with half-value layer equivalent of 1.8 mm. Cu. A choice of two filter thicknesses is offered on the fourth deep therapy machine. A visible wall bracket showing filter not in use is an added safety factor both in this case and in the case of intermediary voltage (Fig. 4).

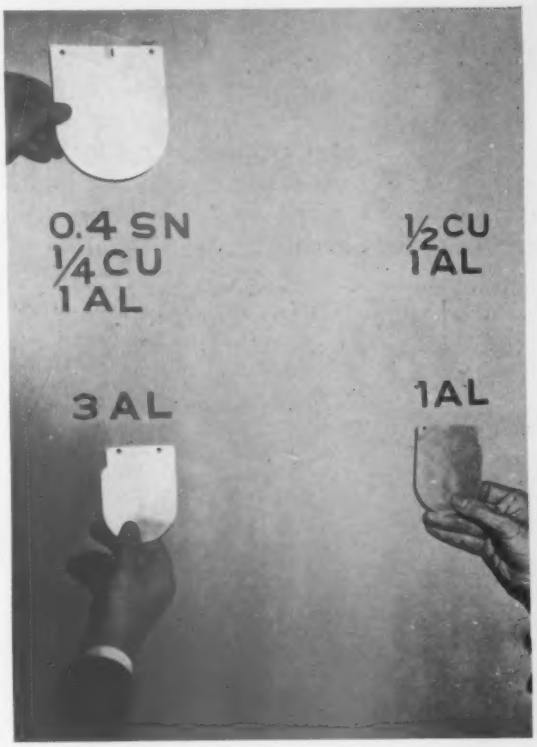

Fig. 4. Wall bracket. Filters held to demonstrate filter value. Only one filter may be removed from this panel at one time. The absent filter gives direct visualization of filter in use.

Target Skin Distance. The advantage of so-called contact therapy is due to the short target skin distance—1.8 cm. The resultant high surface intensity and low depth dose is ideal for treatment of small superficial epitheliomata, plantar warts, angiomas, and certain intracavitary lesions (Howes and Camiel[6]).

Thirty centimeters is considered an advantageous target skin distance in the superficial and intermediate ranges. This distance permits covering of a relatively large area, 10 × 15 cm. Shorter target skin distances would cut down the total size of the field due to construction of the tube head. In accordance with the inverse square law less variation in surface dose will occur with any change in contour off a plane than at shorter target skin distances.

Fifty centimeters is chosen as a feasible target skin distance at 200 kilovolts. Lengthening the target skin distance to 80 cm. and maintaining the filtration at 0.5 mm. Cu multiplies the time by 2.56 (inverse square law).

Cones. Cones are required in all roentgen therapy machines. They obviate error in adjusting target skin distance. Cones permit accurate localization of the beam on the skin and aid in the correct angulation of the tube head to properly focus the central beam into the depth. They also permit the application of pressure when this is to advantage. The only possibility of mistake lies in transposition of the cone size, which should be obvious even to an inexperienced eye.

The bakelite base measures 1 mm. in thickness and the cone is so constructed that the 50 cm. distance is measured to the lower surface of the bakelite. Any scattering by the bakelite is compensated by the fact that all ionization measurements are made with cone in place and the ionization chamber in contact with the cone.

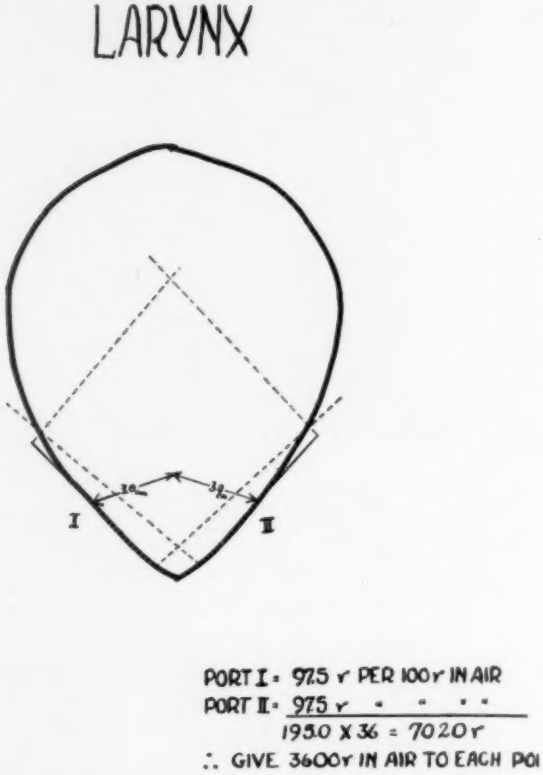

FIG. 5. Cross-section and measurements of larynx and methods of computing "effective depth" and "tumor dose." Note angulation of beam to avoid over-irradiation of opposite skin.

The size of the cones is limited to the following dimensions:

Contact Therapy Tube Head

2.5 cm. in diameter. These cones consist of metal sheaths which slip over the tube head with openings at treatment end of 0.75 cm., 1.2 cm., 1.5 cm., 2 cm. Four similar cones have an additional cylindrical projection of 2 cm. in length.

Superficial Tube Head

10 cm. diameter of lower surface
23 cm. diameter of lower surface
Lead rubber, cut to any desired shape is used to block surrounding areas.

Deep Therapy Tube Heads

2 cm. circle—for intraoral, intrarectal, intravaginal therapy.

4 cm. circle—for use in therapy to sella turcica, lymph nodes in the neck, axilla.

6×8 cm. —for use in therapy to larynx, base of skull, supraclavicular region.

8×10 cm. —for use in therapy to axilla, supraclavicular and inguinal regions.

10×15 cm.—for use in therapy to the pelvis. In small individuals lead rubber blocks cut down the area to 8×15 cm. or 7×15 cm. The area 7×15 cm. has been found to be ideal in treatment to the spine, mediastinum and retroperitoneal space.

20×20 cm.—for use in therapy to the abdomen in treatment of ovarian cancer with peritoneal implants; teratoma with widespread retroperitoneal metastases.

Choice of large areas is based on our knowledge that neoplastic disease is apt to spread beyond the bounds of any palpable tumor.

Half-Value Layer. All roentgenologic apparatus at the Brooklyn Cancer Institute has been calibrated in half-value equivalents. Therefore, the only variant when a patient is treated on one or another installation is intensity or the number of roentgens per minute.

Fifty Per Cent Depth in Water (Tissue). Determination of energy absorption within a given layer of living tissue is difficult if not impossible to measure accurately. The roentgen by its definition represents the energy absorbed within a cubic centimeter of air and in the depth can be considered as a measure of the absorption which takes place within the thimble chamber at that partic-

ular depth. The number of roentgens deliverable into any stratum has been measured in wax, water, masonite, etc. Because of the similarity of the atomic composition of these phantoms and of living tissue, these tables may be directly transposed for estimation of tumor dosage within the body.

Meyer[8] has divided the roentgen-ray beam within the depth into three zones: (1) "upper zone of maximum absorption and greatest radiation efficiency," the lower margin of which he fixed by the d/2 in water, (2) "intermediary zone of lesser absorption and of doubtful efficiency," whose lower margin is limited to the d/4 in water, and (3) "deep zone of minimum absorption coefficients—lowest radiation efficiency," and he further writes, "The effort should be made to select that ray quality wherein the maximum absorption will be brought to bear upon the lesion."

Whenever possible a technique should be chosen where at least the 50 per cent depth in water will reach the desired level. Thus to treat a lesion with a given technique where the 50 per cent depth in water is less than half of the surface beam or to treat any lesion using an insufficient number of fields (Desjardins[3]) to deliver an adequate tumor dose is to disregard physical principles at our disposal and to invite failure. On the other hand, to treat a cancer 3 cm. below the surface with a half-value layer of 4 mm. Al, where the 50 per cent depth in water will vary from 2 to 5 cm. (see Table 1) is not always advisable, even though greater than 50 per cent of the surface dose will reach the neoplasm. In our experience, it is advantageous to use increasingly hard rays and to so angle the tube that the exit beams shall not converge on the surrounding normal tissues. Thus, to treat a larynx (Fig. 5) with a tumor dose of 6,000 r, giving daily treatments as are outlined in a protracted fractional type of treatment cycle with 135 kv. and filtration of 3 mm. Al, would, in our estimation,

Table I

Kilovoltage	Filter	Target Skin Distance	Half-value Layer	50% Depth in Water Minimum[a]	50% Depth in Water Maximum[b]	Approximate Roentgens per Minute
45	None	1.6 cm.	0.3 mm. Al	0.26 cm.	0.6 cm.	13000
45	1 mm. Al	2.1 cm.	1.0 mm. Al	0.5 cm.	0.8 cm.	1700
100	0.5 mm. Al[c]	30 cm.	1.2 mm. Al	1.2 cm.	2.5 cm.	50
100	1 mm. Al	30 cm.	2.0 mm. Al	1.5 cm.	3.0 cm.	35
135	3 mm. Al	30 cm.	4.0 mm. Al	2.0 cm.	5.0 cm.	35
200	0.5 mm. Cu[d]	50 cm.	0.9 mm. Cu[e]	3.1 cm.	8.5 cm.	25
200	0.4 mm. Sn[d,f] plus 0.25 mm. Cu	50 cm.	1.8 mm. Cu	3.3 cm.	9.2 cm.	13[g]

(a) theoretical minimum pencil beam—no secondary radiation.

(b) largest area used in practice (2.5 cm. diameter at 45 kv.; 10×15 cm. area at 100 and 135 kv.; and 20×20 cm. area at 200 kv.). The two columns (a) 50 per cent depth in water, minimum, and (b) 50 per cent depth in water, maximum, give a comprehensive demonstration of the latitude that can be obtained by varying the size of the field with a single ray quality as regards depth dose (see Fig. 1).

(c) 0.5 mm. Al inherent filtration in permanently mounted ionization chamber.

(d) plus 1 mm. Al.

(e) This quality is also used occasionally at 180 cm. target skin distance—for experimental studies.

(f) Thoraeus filter or its equivalent (2 mm. Cu) is used. One apparatus has the copper filtration constructed inherently in the tube head.

(g) the machine with the greater energy capacity in use at Brooklyn Cancer Institute delivers 22 r per min., all factors as listed in table.

be apt to result in necrosis of overlying skin and cartilage. To add filtration and increase voltage is to increase the differential between tumor destruction and skin reaction.

Intensity. The maximum output of each machine is employed. The approximate roentgens per minute then depends upon the capacity of each individual apparatus (Table 1). The biological response of any tumor will depend upon the intensity—r per minute delivered at the depth—just as the surface reaction will vary with similar changes in intensity (Holthusen,[5] Meyer,[8] Quimby,[10] Paterson[9]).

TABLE II

Factors: 200 kv., 1.8 mm. Cu half-value layer, 50 cm. target skin distance
r at depth per 100 r in air

Depth	8×10 cm.		10×15 cm.	
	r per cent	r with scatter	r per cent	r with scatter
0	100.0	133.0	100.0	137.0
1 cm.	99.5	132.4	100.5	137.3
3 cm.	81.2	108.0	83.7	115.3
5 cm.	65.6	87.3	68.6	94.0
8 cm.	44.6	59.3	49.4	67.7
10 cm.	32.0	42.6	37.1	50.8

The average patient will tolerate a total of 200 r in air to each of two large fields daily, or approximately 555 r with backscatter in daily treatments. Only in an exceptional instance has the daily dose been raised to total 600 r in air or approximately 825 r with backscatter.

Depth Dose Tables. All ionization measurements are made as roentgens in air with cone in the tube head. Tables have been prepared by members of the Department of Physics (Braestrup and Blatz) giving depth dose determinations for the different qualities and field sizes in a double column, as shown in Table II. One column represents the percentage roentgens without backscatter at measured depth for each 100 r in air, and the second column, roentgens with scatter at the surface and each centimeter below the surface. This permits rapid transposition from carefully computed r under laboratory conditions to the clinical set-up in each individual case.

Localization of External Fields. All skin fields are outlined by a physician with a preparation of carbol-fuchsin. This has the advantage of semipermanent staining without including silver nitrate as an ingredient. Fifty per cent silver nitrate in mercurochrome has been used but was discontinued when it was found that the secondary radiation from the silver and mercury necrotized the skin superficially Fields on the face and neck are not marked on ambulatory patients. All positioning, however, is carefully checked by a supervising physician. Both the resident physician and the technician are expected to initial each daily record that they have positioned the patient and checked all factors.

Reference may be made to a regional anatomy, as the one by Kaplan and Rubenfeld,[7] for accurate localization of skin fields. It must be borne in mind, however, that tumors tend to distort normal anatomy. Percussion, palpation, roentgenoscopy and roentgenography are all used as aids in accurate localization.

System of Charting. Any record of radiation therapy must be presented in a readable, concise form with minimal duplication. At the Brooklyn Cancer Institute such a form is in use (Chart 1).

The heading of this chart includes:

(1) patient's name
(2) date that the therapy is ordered
(3) diagnosis
(4) anatomical part to be treated
(5) number of fields
(6) size
(7) factors
  (a) kilovoltage
  (b) half-value layer
  (c) target skin distance
(8) number of roentgens in air to be given per treatment to each area
(9) number of areas to be treated per sitting
(10) interval between treatments
(11) estimated tumor dose

The attending radiologist signs this order. The resident radiologist then completes the record by computing the total roentgens in air per field necessary to deliver the requisite tumor dose.

On the reverse side of each therapy sheet (Chart II) is an anatomical chart upon which the radiologist maps the relative location of the fields to be used. Each block represents a skin field and is numbered. This number must agree with the anatomical description of the portal under the heading of "field." Thus the area is diagrammed from two standpoints: (A) the rough anatomical chart and (B) the cross-section drawing.

DEPT. OF HOSPITALS

Roentgen Therapy

Name Mary Smith Date Sept. 8, 1941
Diagnosis Ca. of Breast with fistulous tract.
Treatment Area Abdomen and back

No. of Ports 8 Size 15×15
200 K.V. 1.5 m.a. H.V.L. 50 S.T.D.
Give 2000 r to 2 areas daily. Rest
Tumor Dose 2000 r to ea. quadrant
Roentgenologist M.D.

No. & Date	Field	D.	Ty	mas	Total r per port								Time per Field	Mach. No.	M.A. amp.	Ion. meter Reading
					1	2	3	4	5	6	7	8				
1 9/8/41	upper ant. abdomen	Lung	M	200	200	200							15'	8	20	16
2 9/8/41	lower ant. abdomen	Lung	M	200			200	200					15'	8	20	16
3 9/10/41	Post. upper abdomen	Rt	R	200	100	100	100	100	100	100	100	100	12½	9	10	18
4 9/10/41	Post. lower abdomen	Rt	P	200	100	100	100	100	100	100	100	100	7½	7	25	9
5 9/12/41	upper post. abdomen	Lt	P	200	200	200	200	200	200	200	200	200	15'	6	20	24
6 9/12/41	lower post. abdomen	Lt	R	200	200	200	200	200	200	200	200	200	15'	6	20	24
					Tumor Dose = 2,000 r											
					Duration = 92 Days											
					Skin Dose r Back Scatter per Port = 1320 r											

Chart I.

The technician who supervises each treatment is expected to fill in the following columns:

(1) Number of the treatment and date.

(2) Field, which includes an anatomical description of the area and the arabic number given each area (anatomical chart). These numerals must correspond to the diagram on the reverse side of the therapy sheet.

(3) Signature of the resident radiologist and technician who set up and supervised the treatment.

(4) Number of roentgens in air delivered per field.

(5–13 inclusive) represent the total number of roentgens given to a particular area—one column per field. In these columns the total

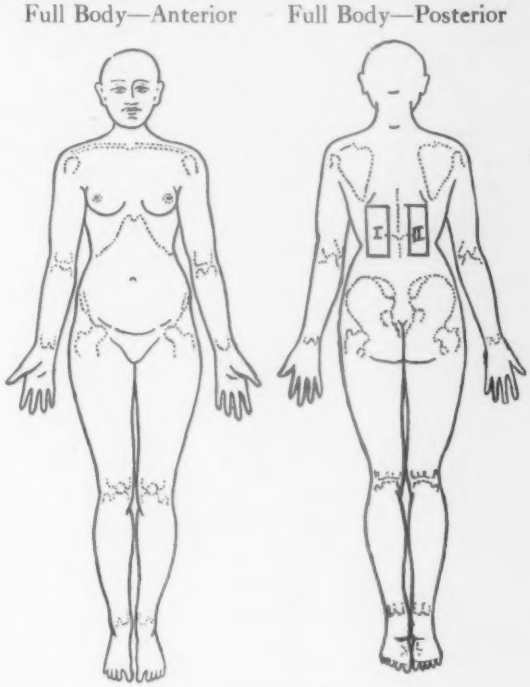

Chart II.

number of roentgens given to the field treated is totaled at every sitting. This computation is considered one of the most significant parts of the record as the total dose delivered to each field can be seen at a glance during any part of the treatment.

(14) The time per field, which is a check on the machine used and the dose given.

(15) The machine number.

(16) Milliamperes, as they differ with the capacity of the several apparatus.

(17) Ionometer reading.

At the completion of the cycle, the resident radiologist summarizes the treatments given by totaling the tumor dose, the time interval, and the skin dose per field; i.e., r with backscatter. Such charting becomes routine and requires but little time and soon is considered indispensable for the completeness of the radiation record.

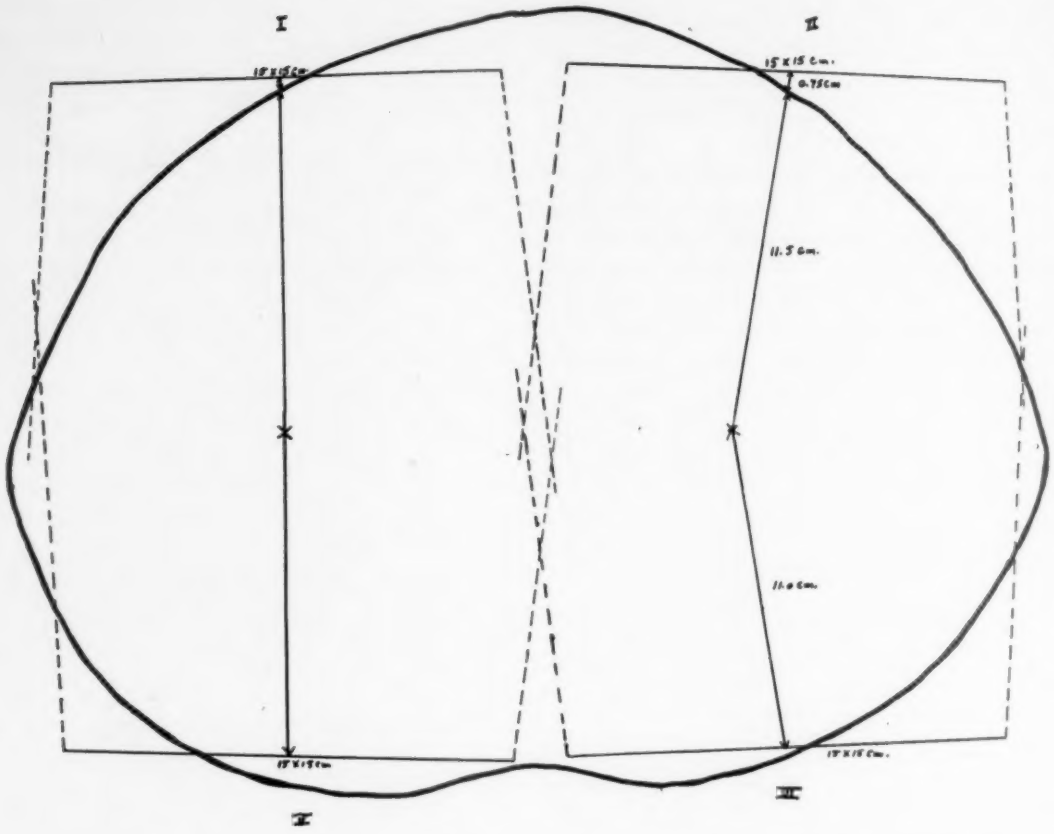

Fig. 6. Cross-section and measurements of abdomen such as are used in computing "effective depth" and "tumor dose" in ovarian carcinomatosis.

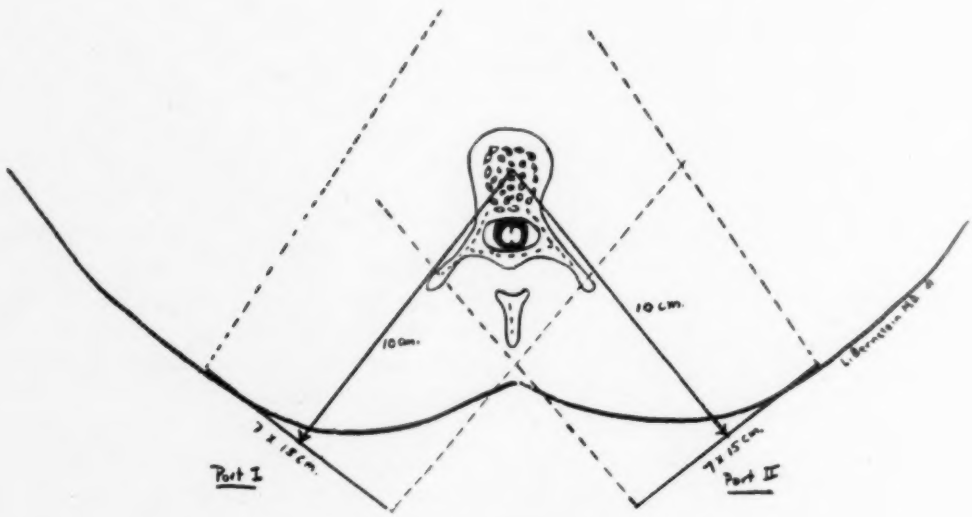

Fig. 7 Cross-section of spine as is used in computing "effective depth" and "tumor dose" in metastasis to spine.

Recording of Tumor Dose. To plot the "tumor dose," a full size body cross-section is outlined on suitable paper. The tumor location is indicated on this drawing. The distance to this point is measured from the center of each surface field (effective depth) (Fig. 1, 2, and 5–8). The depth dose per field for each unit of 100 r in air is then recorded and totaled. This sum represents the number of roentgens at the depth per unit of 100 r in air for all fields. To calculate the total number of roentgens in air to each skin field needed to deliver the prescribed tumor dose, divide the tumor dose by the sum of roentgens at the effective depth and multiply by the unit 100. For example (Fig. 5), 195 r represents the sum of the effective depth doses for each 100 r in air delivered per field. A tumor dose of 7,000 r is prescribed to the larynx, 7,000 ÷ 195 = 36; 36 multiplied by 100 = 3,600 or the number of roentgens in air necessary per field to deliver the prescribed tumor dose. As all lesions within the body are crossfired and as the actual diameter of the part is taken directly from the patient, there can be but little error in this estimation. This error has been calculated as between 5 and 10 per cent even when the tumor site is grossly misplaced. Only occasionally is a sagittal cross-section needed; namely, when a perineal field is included, as for cancer of the prostate, rectum or cervix.

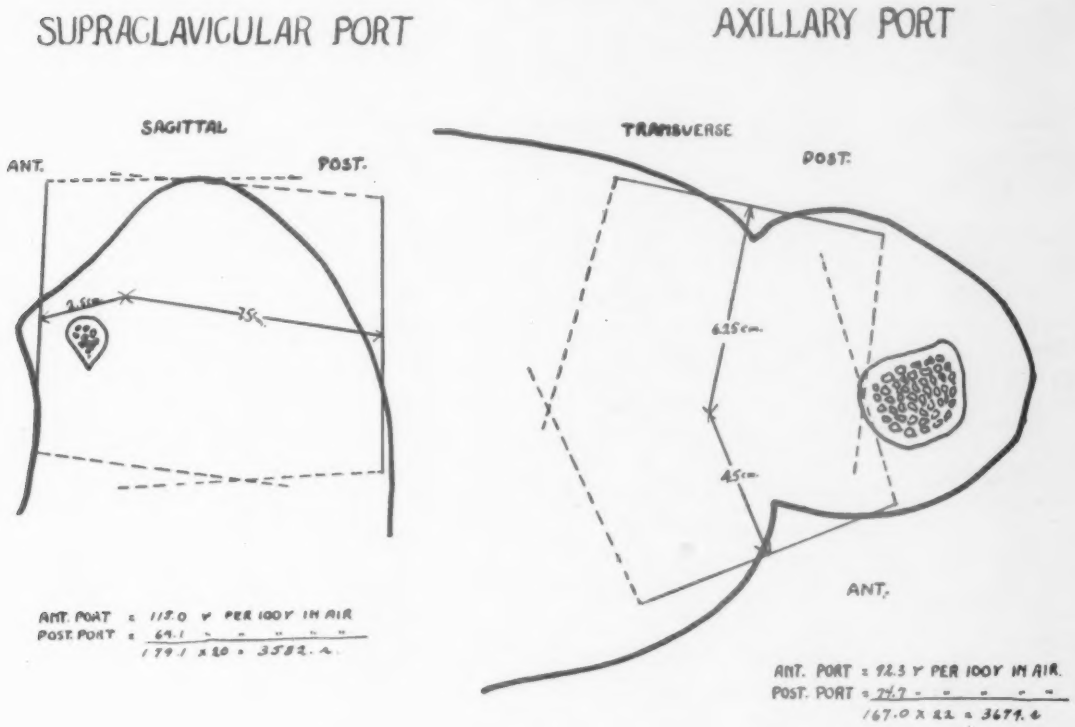

Fig. 8. Cross-section of axilla and sagittal section of supraclavicular region such as is used in computing "effective depth" and "tumor dose."

Dose determination using roentgens in air greatly simplifies time calculation by those supervising the treatment. In most cases, there is only one time factor necessary to refer to for each machine; namely, roentgens in air per minute. The time necessary to deliver 100, 200 or 300 r in air can of course be calculated from this factor. Ac-

Table III

Part	Field Size	Number and Location of Fields	Interval Days	Tumor Dose
Calvarium	10×15 cm.	2 lateral	3	600+ r*
Cerebral metastasis, retrobulbar	4×4 cm.	4(1 lateral (supraorbital (infraorbital (occipital	25	4000 r
Sella turcica	4×4 cm.	3 or 4 (2 lateral (1 frontal (1 occipital	25	4000 r
Nasopharynx	8×15 to 10×12 cm.	2 lateral	14	3000 r
Maxillary antrum	6×8 cm.	2 anterior and lateral	20	5000 r
Oral lip	Triangle 4 to 6 cm. side	1 anterior	12	6000 r
Tongue anterior	2.5 cm. diam.	1 intraoral	12	6000 r
Floor of mouth, alveolar ridge, palate	6×8 to 8×10 cm.	2 lateral	15	3000 r
Tongue posterior Tonsil	6×8 to 8×10 cm.	2 lateral or oblique anterior and posterior	24	4000 r
Hypopharynx	6×8 to 8×10 cm.	2 lateral	24	4000 r
Larynx	6×8 cm.	2 lateral oblique	30	7000 r
Cervical lymph nodes	6×8 to 10×12 cm.	2 anterior and posterior oblique	21	4000 r
Supraclavicular Chart IV	8×10 cm.	2 anterior and posterior oblique	18	3600 r
Axilla Chart IV	8×10 to 10×12 cm.	2 anterior and posterior	18	3600 r
Breast	10×12 to 10×15 cm.	2 lateral	18	3600 r
Chest wall	5×15 cm.	2 tangential	24	5000 r
Mediastinum and esophagus	7×15 cm.	4—2 anterior 2 posterior	55	3000 r
Bronchogenic	8×10 cm.	2 anterior and posterior	30	3000 r
Pulmonary metastases	8×10 cm.	2 anterior and posterior	18	2000 r
Stomach	10×12 cm.	5—2 anterior 2 posterior 1 lateral—left	40	3600 r
Cecum	10×12 cm.	3 anteroposterior lateral—right	30	3200 r
Sigmoid and rectum	10×15 cm.	4—2 anterior 2 posterior 1 perineal field optional	32	2400 r right and left
Kidney	10×12 cm.	3 anterior posterior and lateral	28	4000 r
Bladder and prostate	10×12 cm.	4—2 anterior 2 posterior	32	4500 r
Ovaries plus peritoneal metastases Chart V	10×15 to 20×20 cm.	8—4 anterior 4 posterior	60	200 r each quadrant

Table III (Continued)

Part	Field Size	Number and Location of Fields	Interval Days	Tumor Dose
Cervix and uterus	8×15 to 10×15 cm.	6—3 anterior 3 posterior	42	4500 parametric right and left†
Retroperitoneal metastasis as from teratoma testis	Abdomen 10×12 cm.	8—4 anterior 4 posterior	60	2000 r each quadrant
	Thorax 7×20 cm.	2 posterior oblique	14	4000 r
Spine				
Cervical	7×10 cm.	2 lateral oblique 1 posterior optional	14	4000 r
Thoracic lumbar and sacral Chart VII	7×15 to 7×20 cm.	2 posterior oblique	14	4000 r
Pelvis	10×15 to 10×20 cm.	6—3 anterior 3 posterior	42	2400 r each of 3 fields
Bone metastasis				
Extremities	6×8 to 7×20 cm.	3 to 4	30	4000 r

* Temporary alopecia.
† Often this cycle is divided in half with a two month interval during which radium is inserted.

tually, the physicist charts these time intervals. The radiologist appreciates that such a simplification, i.e., ordering individual treatments as number of roentgens in air, results in variable daily skin dosage depending upon quality of the roentgen-ray beam and the field size, and to a lesser degree upon the angulation of the incident beam. This variation in backscatter and surface dose is of little consequence except in determining the danger zone for possible skin or tissue injury as all treatment is directed primarily toward obtaining an adequate tumor dose. To prevent skin damage, the total surface dose is transposed to roentgens with backscatter and, when necessary (Quimby[10]), the amount of the exit beam added. This proposed total skin dose must be confirmed by the radiologist before therapy is instituted to primary or metastatic cancer.

Table III represents tumor dosages which have been delivered to patients at the Brooklyn Cancer Institute without producing untoward skin reaction, or when suitably angled have not resulted in damage to surrounding structures. These doses must not be considered as curative of cancer or its metastases and are presented only as a basis for further clinical evaluation and comparison.

SUMMARY

1. Standardization and simplification of technique is necessary in maintaining accuracy and efficiency in any department of radiology.

2. Tumor response depends, to a great extent, upon tumor dose.

3. Methods of computing and recording the tumor dose are presented.

4. Tables of tumor doses, such as have been delivered, are included for a comparative basis.*

The authors wish to express appreciation for the work that Mr. Irving H. Blatz has done in preparing depth dose charts and criticism he has made of those parts of the paper referring to radiation physics.

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RADIATION THERAPY IN CANCER OF THE ESOPHAGUS

AN ANALYSIS OF EIGHTY-FIVE CASES OBSERVED DURING THE LAST DECADE*

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INTRODUCTION

THE treatment of cancer of the esophagus is one of the most difficult problems in medicine. In the first place, the anatomical location renders a surgical approach very dangerous; in the second place, most of the patients do not come for examination until symptoms of obstruction have developed pointing to an advanced stage of the disease, and in the third place, the type of neoplasm occurring there is not very radiosensitive. For these reasons only radiation therapy can usually be considered, and it has to be of a palliative nature in the great majority of cases. Therefore it is not surprising that reports of histopathologically proved cures of cancer of the esophagus are extremely rare.[1]

During the last thirteen years (up to December 31, 1941) we have seen in the Department of Radiology of the State of Wisconsin General Hospital, out of a total of 10,962 treatment cases, 85 patients with cancer of the esophagus; 3 additional cases were seen in December, 1941, but are not included here because they were still under treatment. Over 90 per cent of the cases were admitted with advanced lesions and only in a few did the general condition permit of a thorough trial of radiation therapy. No attempt is made to review the literature dealing with this subject, but our own experience in dealing with these patients, the technique of treatment used, the results obtained and 8 illustrative case histories will be related below.

TREATMENT

a. Roentgen Therapy. In all cases where palliative irradiation is indicated we believe that roentgen radiation should be given preference. It is easy to apply, the procedure is less inconvenient for the patient and—above all—much safer than intraesophageal radium therapy. The number of fields used depends upon the location of the growth; in the upper third, two lateral and one anterior field, and in the remaining parts of the esophagus an anterior and a posterior field or two oblique anterior fields suffice. The single daily dose per area does not exceed 150 to 200 r (in air) or a total dose of 2,000 r per field in the upper esophagus and 1,200 to 1,600 r per area in the lower esophagus. The difference in dosage is based on our assumption that even fairly advanced lesions in the upper end of the esophagus are apt to respond similarly to a cancer of the hypopharynx, and by carrying the irradiation further one may add an occasional cure, while for lesions in the lower part of the esophagus the prognosis is much less favorable and the danger of perforation greater. We believe that the producing of severe reactions is not justifiable for strictly palliative purposes.

In earlier cases the usual fractional dose method is used and irradiation is carried to the point of tolerance. This must be determined by the general reaction of the patient and by the local reaction in the mucous membrane. It is desirable to reach

* Presented at the Twenty-seventh Annual Meeting, American Radium Society, Atlantic City, N. J., June 8–9, 1942.

tumor doses of from 3,000 to 4,000 r.

Some radiologists have advocated the use of numerous small fields; however, we prefer to limit the number to three or four. Dosage control becomes rather complicated with an increasing number of areas and accurate direction and duplication of the "cross-firing" from day to day is rather doubtful. With two oblique anterior and two oblique posterior fields or one anterior and two lateral fields better control of the entering beams is assured and treatment can be given day after day with the same technique, and calculation of the dose effective in the tumor is more accurate. The size of the fields depends on the extension of the growth which is of course always localized roentgenoscopically and carefully projected on the skin with some indelible markings.*

b. Radium. Radium therapy alone has been tried by some, both in the form of screens and of seeds. Either method may easily lead to a perforation and especially the implantation of radon seeds in a lesion below the orifice of the esophagus appears dangerous to us. It is our opinion that even the introduction of radon screens loaded into a stomach tube is better carried out after preliminary roentgen therapy. In that case the tumor has shrunk, assuming of course that it responded to irradiation, and this facilitates the introduction of the screens while beginning fibrosis has reduced the danger of bleeding and perforation.

c. Combined Roentgen and Radium Therapy. It is very difficult to give definite rules as to the procedure to be followed in the use of both roentgen rays and radium in the treatment of esophageal cancer. So much depends on the individual reaction that even though a general plan may be proposed it must be subject to modification whenever required. This fact is well demonstrated by the illustrative case histories appended to this paper.

Three principal methods may be used: One consists of the repeated application of five or six roentgen treatments interrupted by one radium application in the form of screens.[2] With the second method, roentgen therapy is given to near tolerance and additional, or one might say "supplementary," radium therapy is administered at the end of the series, and with the third method, roentgen therapy is carried to the very point of tolerance while radium is given three to four months later to destroy any residual tumor.[3] The details of these methods may be summarized as follows:

Plan 1

5 to 6 × 200 r (in air) per field; three to four fields; half-value layer = 1.3 mm. Cu; 300 mg-hr.; filter equivalent to 2.0 mm. brass. Repeat for four weeks, if possible.

Plan 2

200 r (in air) per field; three to four fields; half-value layer = 1.3 mm. Cu; not to exceed 1,800 r per field for three and 1,400 r for four areas; 4 × 300 mg-hr.; filter equivalent 2.0 mm. brass; on four successive days.

Plan 3

200 r (in air) per field; three to four fields; up to tolerance, aiming at tumor dose of 3,000 to 4,000 r. Supplementary radium therapy one to four months later, depending on findings; a total of approximately 100 to 150 mg-hr. (filter equivalent 2.0 mm. brass) per centimeter length of growth in daily sittings of two to three hours.

To illustrate the modifications of the basic techniques described above we briefly quote the case histories of 8 patients who lived one year or longer after the first admission to our clinic.

CASE REPORTS

Upper Esophagus

CASE 1 (No. 5438). L. F., white male, aged seventy-four, was admitted to the Wisconsin General Hospital on March 17, 1936. His chief complaint was one of progressive dysphagia for solid foods and hoarseness for the past four months; he now speaks only in a whisper. There had been a small amount of bleeding from the throat two months before admission. The patient had had a gastric resection for carcinoma of the stomach in 1932. Examination of the larynx revealed a mass on the right side below the epiglottis involving the pyriform sinus. The arytenoid fold was swollen and pushed over past the midline. The mass involving the pyri-

* We are using a saturated solution of picric acid with a sufficient amount of scarlet red powder added to color.

form sinus on the right was necrotic and ulcerated. Externally there was a hard mass involving the area of the epiglottic fold. A biopsy proved this to be a papillary squamous cell carcinoma of the pharyngeo-esophageal junction, malignancy Grade 2. There were cervical metastases. He received 16×150 r (in air), 175 kv., half-value layer = 1.35 mm. Cu, to the right and left upper esophagus including the cervical areas between March 27, 1936, and April 23, 1936.

He returned on June 30, 1936, and stated that he had felt definitely improved since his discharge, but recently had noticed a return of the hoarseness and an increased dysphagia. There was a definite reduction in size of the tumor and of the cervical lymph nodes. In view of his recent therapy he was discharged and returned on July 28, 1936, at which time he complained of hoarseness and dysphagia. A second course of 12×150 r (in air), 175 kv., half-value layer = 1.35 mm. Cu, was given to the right and left cervical areas.

Upon return for a third checkup on October 22, 1936, there was residual radiation reaction and the lesion was progressing in size. In view of the presence of subsiding reaction, additional radiation therapy was not given and the patient was discharged. He returned on January 7, 1937. Laryngoscopic examination revealed a further increase in the size of the mass which pushed the larynx to one side. A roentgenogram of the esophagus showed a large mass filling the pyriform sinuses with partial occlusion of pharynx and esophagus. It was felt that further radiation therapy was not indicated and he was discharged to the care of his local physician. He died in July, 1937. Observation period: one year, three months.

Case II (No. 6463). E. S., white male, aged sixty-two, was referred to the Department of Radiology of the Wisconsin General Hospital on April 13, 1937. In January, 1937, the patient first noticed dysphagia, a feeling that his throat "clamped down" on the food. He had had an ulcer of the stomach in 1930. A roentgenogram of the esophagus revealed a complete obstruction at the level of the manubrium. A gastrostomy was done in March, 1937. No biopsy was taken due to the location of the lesion. Following convalescence he received 10×200 r (in air) 175 kv., half-value layer = 1.05 mm. Cu, to the anterior and posterior upper esophageal fields.

A checkup on May 25, 1937, revealed the patient's general condition as fairly good. On

Fig. 1. Case III. Appearance of esophagus on July 5, 1938.

roentgenoscopic examination there still was complete obstruction of the esophagus. A roentgenogram of the esophagus taken on December 16, 1937, his last visit to the clinic, showed considerable improvement, the obstruction was no longer complete, but an area of narrowing 5 cm. long was still present at the level of the manubrium. His family physician reported that he died on January 24, 1939. Observation period: one year, nine months.

Case III (No. 7585). R. A., white male, aged seventy, was admitted to the Wisconsin General Hospital on June 28, 1938, with an intermittent but progressive dysphagia of one year's duration. Esophagoscopy revealed a mass at the base of the hypopharynx and the esophageal orifice. Biopsy proved it to be a squamous cell carcinoma of the esophagus of Grade 2 malignancy. Beginning on July 5, 1938, he received 14×150 r (in air), 175 kv., half-value layer = 1.35 mm. Cu, to three fields, the right and left cervical and anterior upper esophagus.*

Roentgenograms of the esophagus on August 19, 1938, and October 21, 1938, showed a definite reduction in size of the lesion. His condition remained satisfactory and on November 7,

* According to our estimate the tumor dose administered in the first series amounted to approximately 3,600 r and that administered in the second series to approximately 1,800 r.

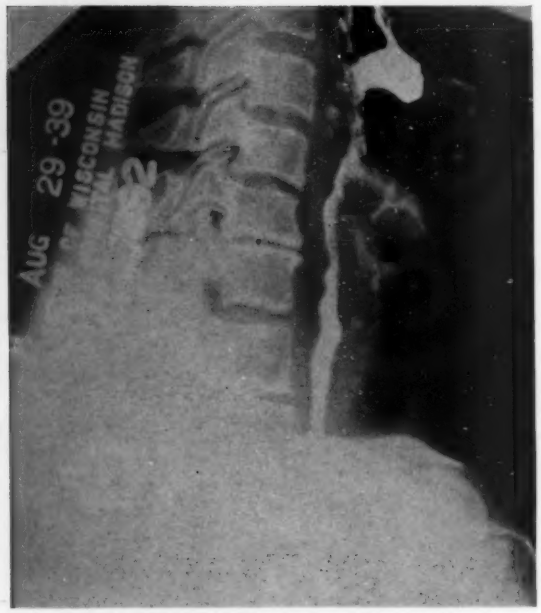

FIG. 2. Case III. Appearance of esophagus on August 29, 1939.

1938, he received a second course of 8×200 r (in air), with the same technique, to the right and left upper esophagus. A roentgenogram of the esophagus on August 29, 1939, showed the thick barium paste passing quite readily through the involved area with only a slight deformity in the supraclavicular region (Fig. 1 and 2). In January, 1941, he complained of dysphagia with solid foods. A roentgenogram of the esophagus at that time revealed a constriction with a small comma-shaped diverticulum on the right lateral wall, distal to the origin of the esophagus. The diverticulum was felt to be due to scarring; the rest of the esophagus was normal. He was next seen by his local physician in December, 1941, and his condition was reported as good, and he was free of any esophageal symptoms of dysphagia. Examination here on October 14, 1942, did not reveal any recurrence. Observation period: four years, four months.

CASE IV (No. 4228). L. L., white female, aged fifty-seven. She was referred by her family

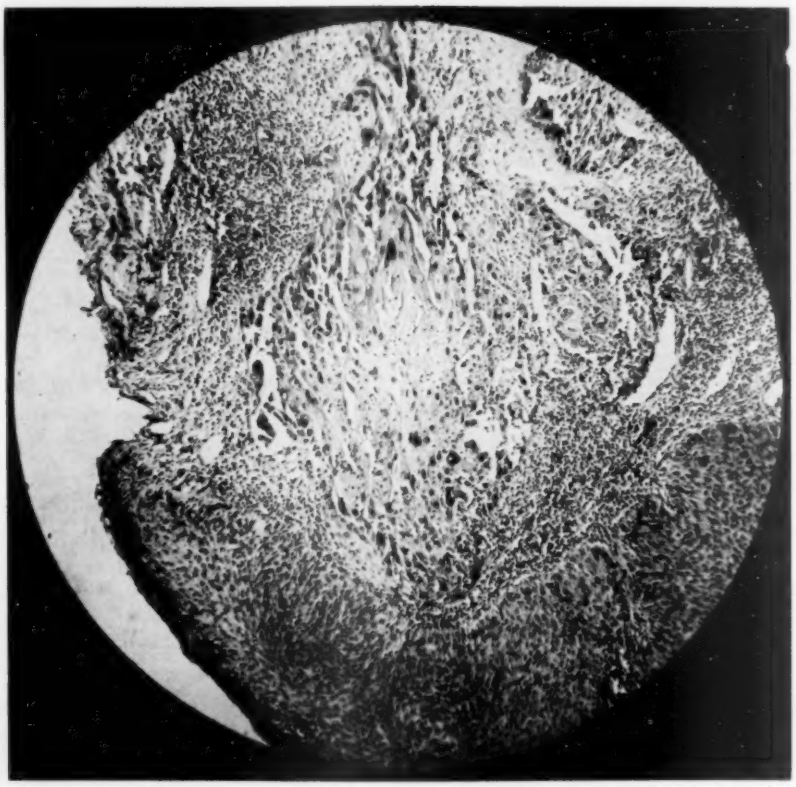

FIG. 3. Case IV. Photomicrograph of biopsy taken in September, 1934, showing squamous cell carcinoma, Grade 2 (magnification 60 ×). (Courtesy *Mississippi Valley Medical Journal.*)

physician on September 23, 1934, with the complaint of dysphagia. About a year before the patient had noticed difficulty in swallowing which grew progressively worse; she lost 35 pounds during that time. Roentgen examination showed a slight constriction at the upper end of the esophagus but it was not entirely characteristic of carcinoma. However, laryngoscopic examination revealed a large red mass posterior to the epiglottis blocking the orifice of the esophagus. Biopsy was done and the microscopic examination showed a squamous cell carcinoma (Fig. 3).

Because of the firmness of the tumor and its accessibility it was decided to implant ten gold radon seeds (0.9 mc. each) into the mass, combined with deep roentgen therapy to both cervical regions. The latter was started on October 1, 1934, and the radon seeds were inserted on October 2. After treatment with 6×150 r (in air) per field, irradiation had to be discontinued because of a severe local reaction, which was without doubt chiefly due to the interstitial irradiation. Re-examination on November 5 showed that the neoplasm had been reduced to about one-fourth of the original size. The patient felt better, could eat regular diet, and the voice, which had practically been lost a week after the first treatment, had considerably improved. Examination on November 19 showed very little residual tumor tissue; the reaction had subsided and a second series of roentgen treatments was given with the same dosage as in the first series.

Several examinations were negative for recurrence until on July 11, 1935, there appeared a lymph node of about the size of a walnut in the right anterior cervical region, which was considered metastatic, and there was also a possible recurrence at the site of the primary focus. A course of eight treatments with the same dose as before was administered which was followed by a very severe reaction in the throat with marked hoarseness. Treatment was resumed on September 30 and six exposures were then given.

The patient returned on December 9, 1935, and at that time there was a definite recurrence in the upper end of the esophagus. Ten treatments were given with a total dose of 1,000 r (in air) over each cervical area. The patient did not return until April 20, 1936, when laryngoscopic examination showed some edema at the upper end of the esophagus with possible recurrence of the original growth. Six treatments with a total of 900 r (in air) to each cervical region were given.

Fig. 4. Case iv. Roentgenogram taken on October 8, 1941, showing radon seeds in front and posterior to the lumen of the esophagus with diffuse stricture of the upper 2 or 3 inches and aspiration of barium into the trachea. (Courtesy *Misssissippi Valley Medical Journal.*)

In January, 1937, the patient returned for re-examination. There was no evidence of recurrence at the site of the primary lesion nor any glandular involvement. The roentgenogram of the chest was negative for metastases. A lateral roentgenogram of the neck showed the radon seeds in the wall of upper end of the esophagus, some of them posterior to the lumen. The patient was not seen again until October, 1941, when she was admitted to the hospital with the complaint of difficulty in swallowing. Laryngoscopic examination did not show any evidence of recurrence and roentgen examination revealed stenosis of the upper end of the esophagus apparently due to fibrosis following irradiation (Fig. 4). Dilatation of the esophagus was started and on re-examination on November 6, 1941, approximately one month after admis-

Fig. 5. Case v. Appearance of esophagus on September 23, 1940.

sion, the patient was able to swallow a thin barium mixture much better; the lumen of the esophagus at its upper end was somewhat larger and maintained a smooth contour. Observation period: seven years.

Middle Third of Esophagus

Case v (No. 9795). K. K., white male, aged eighty-four, was admitted to the Wisconsin General Hospital on September 21, 1940. In April, 1940, the patient noticed dysphagia, and one month prior to admission regurgitated solid food, and for the past two weeks all liquids were regurgitated. There had been a 37 pound weight loss. A roentgenogram of the esophagus revealed an annular cancer of the middle third, producing a high grade of obstruction. A gastrostomy was performed on September 24, 1940. No biopsy of the lesion was obtainable. Upon recovery he received 9×200 r (in air) with 400 kv., half-value layer = 2.4 mm. Cu, to the anterior and posterior mid-esophagus. He returned on January 14, 1941, for a second course of 9×200 r (in air), same technique as before. At that time he tolerated both liquids and solids equally well (Fig. 5 and 6). On March 21, 1941, the patient reported that he could swallow solids with ease. Roentgen examination on May 22, 1941 revealed some irregular narrowing at the site of the lesion, but considerable improvement since the original examination; thick paste showed only a moderate delay. No therapy was given at this time.

During his last admission in August, 1941, he complained of severe upper lumbar pain; he associated this with a fall in 1940. Roentgenograms of the chest, spine and pelvis at this time revealed compression fractures in several of the mid-dorsal vertebrae, and also in the first lumbar vertebra; however, it was felt that these fractures were post-traumatic and not of metastatic nature. He could eat all food and had not used the gastrostomy tube with the exception of the first two weeks following his initial discharge. He had had no regurgitation or emesis, but stated that his appetite was not very good and that his stomach filled up quickly. He had lost 6 pounds in weight since May 22, 1941, yet physical examination revealed no abdominal masses. He was discharged without further therapy. A communication from his local physician stated that the patient died on December 22, 1941. This was approximately two months after his last discharge and his esophagus was practically closed at his death and he could only swallow sips of water. Observation period: one year, three months.

Fig. 6. Case v. Appearance of esophagus on January 14, 1941.

Case vi (No. 9277). J. H., white male, aged sixty-three, was admitted to the Wisconsin General Hospital on March 12, 1940, complaining of progressive dysphagia, first for solid foods and then for liquids for the past eight months. He had lost 42 pounds during the past year. An esophagoscopy and biopsy revealed a transitional cell carcinoma of the esophagus at the junction of the upper and middle thirds with a high grade obstruction. In April, 1940, he received 10×200 r (in air), 400 kv., half-value layer = 5 mm. Cu, to the anterior and posterior upper esophagus. An esophagoscopy on April 17, 1940, following therapy, showed the mass to be reduced to about one-half its original size. A roentgenogram on June 4, 1940, showed a distinct improvement in the appearance of the lesion, the lumen being definitely larger than on the first examination.

On June 28 and 29, 1940, radon screens were placed in the esophagus and a total of 300 mc-hr. was given, the filter was 0.5 mm. silver plus 1.0 mm. brass. The screens could not be passed on June 30, 1940, and a short series of 5×200 r (in air), 400 kv., half-value layer = 5.0 mm. Cu, was given to the anterior and posterior mid-esophageal fields. A roentgenogram on September 9, 1940, revealed an increase in the degree of obstruction and a gastrostomy was done on September 20, 1940.

He returned at three month intervals and his condition was satisfactory until June 23, 1941, at which time only fluids could be taken by mouth. A roentgenogram on July 7, 1941, revealed a high grade obstruction and he received a short course of 5×200 r (in air), 400 kv., half-value layer = 5.0 mm. Cu. to the anterior and posterior mid-esophagus. A communication from his local physician stated that the patient died on January 9, 1942. Observation period: one year, nine months.

Lower Esophagus

Case vii (No. 5803). P. S., white female, aged forty, housewife, was admitted to the Wisconsin General Hospital on May 27, 1936. Since July, 1935, the patient has had a slowly progressive dysphagia and on admission could swallow only liquids. There had been a 76 pound weight loss, and a roentgenogram revealed a cancer of the distal third, producing a moderate delay in the passage of a thin barium mixture. On June 22, 1936, a gastrostomy was done and on July 23, 1936, a transthoracic exploration revealed an inoperable cancer of the esophagus. Following convalescence the patient received 10×200 r (in air), 175 kv., half-value layer = 1.05 mm. Cu, to the anterior and posterior lower esophagus. She was quite nauseated during the roentgen therapy and the gastrostomy feedings had to be decreased in amount. The patient left the hospital in only fair condition and that was essentially her status for six months following her discharge. Her condition became progressively worse from March, 1937, until her death on December 4, 1937. Observation period: one year, four months.

Case viii (No. 8364). L. S., white male, aged thirty-nine, was admitted to the Wisconsin General Hospital on April 20, 1939, with a history of weakness and dysphagia for solid foods of three months' duration. There had been a 20 pound weight loss in the last nine months; a history of vomiting one pint of blood two months prior to admission and postprandial vomiting for the past six weeks.

Roentgenograms of the upper gastrointestinal tract revealed a large polypoid mass protruding into the fundus of the stomach and involving several inches of the distal end of the esophagus, producing a moderate obstruction to the passage of the barium mixture. A gastrostomy was done on April 29, 1939; after convalescing he received a course of 10×200 r (in air), 175 kv., half-value layer = 1.35 mm. Cu, to the anterior and posterior epigastrium. Roentgenograms of the upper gastrointestinal tract on August 4, 1939, showed only a minimal amount of delay of the passage of both thin and thick barium mixtures at the cardiac orifice; and the persistence of a thickening of the gastric wall on the medial side of the fundus around the cardiac orifice.

On August 10, 24, 31 and September 7, 14 and 28, 1939, the patient received 300 mc-hr. from radon screens in the esophagus, the filter used being 0.5 mm. silver plus 1.0 mm. brass. Physical examination on November 1, 1939, showed that he swallowed solid foods with great ease, but that the lesion in the stomach was progressing in size. Further therapy was advised and he received 8×200 r (in air), 175 kv., half-value layer = 1.35 mm. Cu, to the anterior and posterior epigastrium. A roentgenogram on January 22, 1940, revealed an increase in size of the esophageal lesion with the production of a high grade obstruction. He received no radi-

TABLE I

DISTRIBUTION OF CASES 1928–1941

Year	Number
1928	2
1929	1
1930	4
1931	1
1932	5
1933	3
1934	8
1935	6
1936	5
1937	8
1938	12
1939	14
1940	9
1941	7
Total	85

ation therapy at this time in view of his physical condition and recent therapy.

The patient returned in a greatly weakened condition on October 9, 1940. He had been unable to eat anything since his previous discharge, subsisting on liquids alone. Roentgenograms of his chest were negative for metastases. Again he was discharged without therapy and returned on June 25, 1941, much weaker, complaining of hoarseness and persistent blood-tinged sputum. Suprasternal metastases were present and chest roentgenograms revealed an aspiration pneumonia but no evidence of metastases. He was discharged to the care of his family physician without further therapy and died on July 19, 1941. Observation period: two years, three months.

ANALYSIS OF CASES

In Table I is shown the distribution as to years of admission and in Table II the age and sex incidence. It appears that during the sixth and seventh decade we find the largest number of lesions in men; the ratio of males to females is almost 5 to 1. In our group the middle third of the esophagus was involved most frequently (Table III). In over one-third of the patients we were able to obtain a biopsy; squamous cell carcinoma was found most often (Table IV). Accurate information as to distant metastasis was available in 15 cases; their distribution is indicated in Table V.

TABLE II

AGE INCIDENCE

Age	Male	Female	Total
31–40	1	1	2
41–50	7	5	12
51–60	29	3	32
61–70	24	5	29
71–80	8	1	9
81–90	1	—	1
Total	70	15	85

TABLE III

LOCATION OF LESION

Upper third	21
Junction of upper third with middle third	2
Middle third	33
Junction of middle third with lower third	5
Lower third	19
Junction of lower third with stomach	2
Total	82*

* The complete records of 3 patients could not be found.

TABLE IV

HISTOPATHOLOGY

Type	Number
Squamous cell carcinoma	19
Prickle cell carcinoma	6
Adenocarcinoma	3
Papillary squamous cell carcinoma	2
Transitional cell carcinoma	1
Total	31

TABLE V

DISTRIBUTION OF METASTASES

Mediastinum and lung	2
Supraclavicular lymph nodes	2
Cervical lymph nodes	4
Peritracheal lymph nodes	1
Aortic lymph nodes	1
Trapezius	1
Liver	1
Larynx	2
Dorsal vertebrae	1
Total	15

A study of Table VI shows clearly the hopelessness of the prognosis in cancer of the esophagus as far as a cure is concerned; this is largely due to the fact that we see these patients too late. For that reason the degree of palliation obtained and the survival of one case for over four years and of another for over seven years are encouraging. The average duration of life from the time the diagnosis was established was 6.7 months for our group; however, about 10 per cent exceeded this average survival period. Nielsen,[3] in an analysis of 45 cases

TABLE VI

OBSERVATION PERIODS

	Number of Patients
0 to 3 months	32
3 to 6 months	19
6 to 12 months	26
1 to 2 years	5
2 to 3 years	1
3 to 5 years	1
5 years and over	1
Total	85
Average per patient: 6.7 months	

of cancer of the esophagus treated during 1913–1930 and 109 cases treated during 1931–1938, found an average length of life of 4.5 and 7 months respectively. One patient remained free from symptoms two and one-half years following treatments, one patient three and one-half years, and another one, whose lesion was in the upper end of the esophagus, six and one-half years.

COMMENT

The one question arising in our minds is naturally: What can we do to improve the results in the treatment of cancer of the esophagus by roentgen and radium irradiation? As in most other cases of cancer the main effort must be directed toward an education of both the general practitioner and the public in order to detect these lesions in as early a stage as possible. The next problem concerns our technique of treatment. It is without doubt difficult to administer high tumor doses within the esophagus because of its anatomical location and the always present danger of perforation, especially if roentgen rays and radium are combined. Whether or not the higher tube voltage available now can materially improve the situation cannot be definitely stated as yet. We are working on this plan using 400 kv. with a half-value layer of 5 mm. Cu, and will report later as to the results. The only positive statement we can make based on this review is the fact that it *is* possible to cure a histologically proved case of squamous cell carcinoma of the upper end of the esophagus, for at least a seven year period, if the treatment used is a combination of roentgen rays and radium. To that we may add that palliative roentgen therapy even in advanced cases is of definite value.

SUMMARY

1. Eighty-five cases of cancer of the esophagus treated in the Department of Radiology, University of Wisconsin, from 1928 to 1941, are reviewed.

2. The technique of roentgen and radium therapy is described and 8 illustrative case histories are reported.

3. Most cases are admitted in an advanced stage of the disease; even then roentgen therapy offers various degrees of palliation.

4. The average duration of life after admission was 6.7 months; however, about 10 per cent exceeded this period.

5. One case of cancer of the upper end of the esophagus treated by roentgen irradiation alone is alive and well for over four years, and another treated by roentgen irradiation and implantation of radon seeds is alive and well for over seven years; in both the diagnosis was confirmed histopathologically.

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DISCUSSION OF PAPERS BY DRS. HOWES AND BERNSTEIN AND POHLE AND BENSON

DR. JOHN V. BLADY, Philadelphia. Dr. Howes and Dr. Bernstein are to be congratulated on their presentation. Their topic is of current interest and vitally important. It is gratifying to know that their system of records is based on *calculations of tumor dosage* for each individual case. The old method of prescribing a routine series in all cases for a given condition is beset with dangers. As they point out, with this technique difference in body size diameters may give tumor dose differences of nearly 80 per cent. This may represent the difference between a cure or a failure. By predetermining the approximate tumor dosage that one wishes to administer in a given case, it is possible to define the exact technique as to size and number of fields, the amount of irradiation each field can safely tolerate and other factors.

I was sorry to hear the old term "biological reaction" discussed in relation to increased filtration. A comparison of the effect of increasing target skin distance from 70 to 100 cm., for example, versus the increase of filter from 0.5 mm. to 2.00 mm. Cu shows that the increase in the depth dose is the same in both cases where all other factors are equal.

It must be remembered that for the same dose in air increasing filtration from 0.5 to 2 mm. Cu decreases backscatter and therefore decreases the skin dose. For a 100 cm. sq. field, for example, the backscatter is 26 per cent for 2 mm. Cu and 36 per cent for 0.5 mm. Cu. Thus, it is necessary to give 8 per cent more roentgens in air to obtain a skin dose equivalent to that with the thinner filter. Incidentally, this may explain the so-called biological difference in the erythema that has been referred to so often in the past.

The importance of biopsy in any method of therapy must always be re-emphasized. This is never so outstanding as when one reviews old records and notes the great number of cures walking among us on whom the clinical diagnosis of neoplasia was never proved. Of course such clinical diagnoses or impressions naturally give most excellent results. The good rule in every case of a suspected neoplasm would be that *treatment becomes first in importance only after the diagnosis of cancer is histopathologically verified or otherwise proved.*

Cancer of the esophagus is a most disappointing disease. Our results at Temple University Hospital are similar to those reported by Drs. Pohle and Benson. From 1931 to 1941, inclusive, we have seen a total of 60 cases. Nineteen were in the upper one-third or cervical esophagus; 17, middle third, and 24 in the lower third. Of the 19 cases in the upper third, 2 are living—one eight years and the other one year. Of the 17 in the middle third, 3 are living—1 three years and 2 less than one year. Of the lower third none survived. These results are disappointing and discouraging.

It is my feeling that radiation therapy with curative intent may be employed in lesions situated in the upper or middle third, but that it is definitely not indicated, except for palliation, for lesions in the lower third and cardia of the stomach.

It is possible that the surgical successes so far recorded in this field may offer greater hope for the unfortunates afflicted with this disease. Naturally, surgical successes, too, are dependent on the early discovery of symptoms and recognition of the organic disease in its early stages.

DR. JOHN F. HYNES, Wilmington, Delaware. I would like first of all to discuss the paper of Dr. Howes. I think the author is to be complimented on his clear presentation of the problems facing the radiologist who is working in a busy clinic with a number of individuals concerned in the treatment of the cases. My problems are quite a bit easier since the patient volume is only about 40 per cent of his, and all the treatment is in the hands of myself and a single technician; consequently, our records need not be quite so elaborate. Under the conditions he has outlined the record system is a contribution to the management of such a large department.

I would have liked to hear more emphasis on the accurate anatomic localization of the disease. Dr. Howes did emphasize the importance of microscopic pathology—diagnosis by biopsy—but did not give very much attention to gross pathology—the extent and exact location of disease.

He made an important point in the consideration of tissue roentgens actually delivered to the neoplasm. Of equal importance is the consideration of tissue roentgens delivered to the surrounding normal structures. I think particularly of the bowel in the treatment of cancer of the cervix uteri. A patient of mine who developed gangrene of the terminal ileum following roentgen irradiation of the cervix convinced me that it was very necessary to calculate tumor doses. This patient was exceptionally thin and received too much radiation to her small intestine.

I cannot agree with Dr. Howes entirely that the late skin changes are much affected by the filtration within the range of filters under discussion. Some years ago I had the opportunity of completing a clinical experiment which was started by Dr. Ashbury. We treated a series of patients with cancer of the cervix through six fields, using different filters on various fields. For example, on the anterior abdominal wall one field was treated using a 0.5 mm. copper filter, the other field using 2 mm. of copper; one lateral field with 0.5 mm. of copper, the other lateral with a Thoraeus filter equivalent to 2 mm. of copper, and so on. In doses totalling as high as 3,000 roentgens per field, measured in air, the only perceptible difference in the immediate reaction was that the erythema appeared a day or two earlier in the field with the lighter filter. These patients were followed for several years and there was no apparent difference in the late skin changes. It was impossible to tell which side of the abdomen or back had received more heavily filtered irradiation without reference to the original records.

Some of the tissue doses that Dr. Howes tabulated at the end of his article seemed rather high. I think particularly of the tissue dose of 7,000 roentgens in the larynx, which would give trouble in the great majority of cases.

I did not have the opportunity of reading Drs. Pohle and Benson's paper so that I haven't a prepared discussion. However, a few points occurred to me in the discussion of cancer of the esophagus. As with everybody, my experience has been very unhappy.

During the past six years 11 cases of carcinoma of the esophagus were admitted to the Carpenter Memorial Clinic. In all cases the primary tumor was located in the thoracic esophagus. We classify carcinoma arising in the upper cervical esophagus as carcinoma of the hypopharynx. We had no patients with carcinoma of the lower cervical esophagus. Three patients had adenocarcinoma, presumably secondary to carcinoma of the cardia, the remainder had squamous carcinoma.

Of the 11 cases, 5 were treated by external irradiation. The others were not treated because of the extremely advanced stage of their disease. Four patients, including one with adenocarcinoma, had temporary palliation of symptoms, but all died within a year. In one of these cases complete destruction of the esophageal carcinoma by irradiation was demonstrated at autopsy. The patient died suddenly from rupture of the aorta into the esophagus. This case demonstrates the problem which is always present when cancer of the esophagus is irradiated. Anatomically the esophagus is a thin walled, rather fragile, muscular tube which is invaded early by cancer; consequently, destruction of the cancer frequently results in perforation of the esophageal wall.

We have had the opportunity to witness a recent successful esophagectomy. In my opinion the greatest advances in treatment of cancer of the esophagus will probably be made in the field of thoracic surgery.

Dr. Edith H. Quimby, New York City. Such a definite scheme of dosage calculations is valuable. It is becoming more and more generally realized that it is essential to know the dose delivered to the lesion undergoing treatment, and to the surrounding tissues, as well as the dose measured in air and the dose measured on the skin. The two last are important for the records, but the first is more important from the point of view of what is going to happen to the disease.

The point has been well brought out that the size of the patient is extremely important in determining the amount of radiation delivered to the tumor. It is also desirable to consider the advantages and disadvantages in using other filters than 0.5 mm. copper, and other distances than 50 cm. The employment of heavier filters, longer distances, or both, for deep-seated lesions, is generally accepted. Less attention is sometimes paid to shorter distances for superficial lesions, although this is a possible means of economically making up for the longer exposures necessary for long distances, and at the same time lessening the radiation dose to structures situated deeper within the body than the diseased region. Emphasis should be placed upon the modification of physical factors by the radiologist to suit the individual case.

If it is important to specify tumor doses in roentgen therapy, surely this is also true for radium. There is now available plenty of information for the calculation of such doses. It is just about as bad from the point of view of completeness of information to talk about a radium dose in terms of milligram-hours as it is to use milliampere-minutes to specify a dose of roentgen rays. No radiologist would think of doing this at the present time. In the case of radium, milligram-hours will continue to be stated for purposes of specifying the exposure, just as are roentgens per minute and minutes on the roentgen record; this must be supplemented by a statement of the dose to the tumor.

DR. HOWES (closing). I'm afraid I am one of the diehards when it comes to the question of biological effect and quality of radiation. More penetrating roentgen rays produce less skin reaction and fewer late skin changes and permit the delivery of higher tumor dosage within the limits of the d/2 precept as advanced by Dr. Meyer. I appreciated that I was going to be criticized on this particular point, since this is still a debatable subject.

I will state what I neglected to say before, that one of our reasons for choosing the increased Thoraeus filtration was the fact that we were able to save 20 per cent in time over the increased distance; namely from 50 to 70 cm. with the lesser filtration.

I also feel that the paper does not emphasize sufficiently the importance of intensity, the roentgens per minute and the rhythm with which treatments can be given, and the effect which can be produced by change in rhythm. At the present time we are attempting to change that rhythm in that we are taking, for instance, some of our laryngeal lesions, and instead of giving the large total dose which we have given with a great deal of safety in our experience with the factors as outlined, we are attempting to give 4,800 r within ten days after Dr. Paterson's suggestion to cut the time interval.

I realize that Dr. Lenz is doing just the reverse and spreading the time interval.

As to the localization of disease, I brought out in the paper and Dr. Quimby brought out in her article that in the crossfiring of a lesion in the neck using two fields, even though you grossly displace the tumor site, the effective tumor dose cannot be more than 5 or 10 per cent in error. All deep lesions are crossfired and after checking this, we feel that as far as the location of the tumor is concerned we cannot be over 10 per cent off in our estimation of the depth dose.

The cones are intentionally reduced in number; this is in an effort to cut down all factors to a minimum. It has been our experience in a very large clinic that this number of cones is adequate.

DR. BENSON (closing). We would like to thank the discussants of our paper and we, too, like Dr. Hynes, feel that surgery has a definite place in the treatment of cancer of the esophagus, particularly putting the part at rest, while the inflammation subsides and the therapy is going on.

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LOCALIZATION AND CONCENTRATION OF STAPHYLOCOCCUS ANTITOXIN IN AREAS OF RABBIT'S SKIN TREATED WITH ULTRAVIOLET RADIATION*

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IN RECENT publications it has been shown that staphylococcus antitoxin following an intravenous injection localizes and concentrates in areas of rabbit's skin where xylol is applied.[5,7,8] Foreign serum and antibodies have been demonstrated by others in areas of inflammation. Menkin[3] demonstrated horse serum following an intravenous injection in areas of inflammation by extracting the tissue in saline and using the precipitation reaction. Fox[2] used a similar technique to demonstrate the localization and concentration of agglutinins in areas of inflammation.

In the studies upon the localization and concentration of antitoxin in areas of inflammation it was thought that the phenomenon resulted from an increase in tissue permeability. This permitted the antitoxin to concentrate in the specific area. In unpublished experiments it has been found that trypan blue when given intravenously localizes and concentrates in areas of rabbit's skin treated with ultraviolet radiation. Since this colloidal dye localizes and concentrates as a result of a change in tissue permeability it was considered likely that staphylococcus antitoxin would concentrate also in an area of skin previously treated with ultraviolet radiation.

METHODS AND MATERIALS

Normal rabbits are used. They are carefully shaved twenty-four hours or longer before the experiment is begun. An area of skin approximately 4 by 6 cm. is treated with ultraviolet radiation. A hole 4 by 6 cm. is cut into a hand towel. This is placed over the area of skin to be treated. The ultraviolet radiation is obtained from a mercury arc lamp.* The lamp is placed directly over the skin at a distance of 10 inches. The time of the exposure varies from seven to ten minutes. The rabbits are sometimes treated on both sides of the abdomen. The staphylococcus antitoxin† is injected intravenously (5.0 cc., 4,200 units) into the marginal vein of the ear immediately after the skin is irradiated.

Staphylococcus toxin (0.1 to 0.2 cc.) is injected intradermally into the ultraviolet treated areas of skin and into the untreated skin of each animal. The presence or the absence of skin necrosis at the site of the injection of the toxin in the ultraviolet treated areas of skin is considered indicative of either the absence or the presence of antitoxin. The control for each experiment is the presence of necrosis at the site where the toxin is injected in the normal skin. A marked variation in the size of the necrosis in each rabbit is also considered significant. Slight variations in the size of the necrosis may be observed when a series of injections of equal size are made in a single rabbit.

In the control experiments the skin is treated with ultraviolet radiation and staphylococcus toxin is injected similarly into the treated and untreated skin.

EXPERIMENTAL

A local area of skin approximately 4 by 6 cm. on each of two rabbits was treated with ultraviolet radiation for seven minutes. Immediately following this irradiation 5.0 cc. of staphylococcus antitoxin was in-

* Aided by a Grant from the International Cancer Foundation.

* This lamp was supplied by the Burdick Corporation of Milton, Wisconsin. It is a QA-250 lamp.

† The staphylococcus antitoxin and staphylococcus toxin were supplied by the Lederle Laboratories of Pearl River, New York.

TABLE I

SKIN NECROSIS PRODUCED BY STAPHYLOCOCCUS TOXIN IN RABBITS TREATED WITH ULTRAVIOLET RADIATION

Rabbit No.	Size of Necrosis in Centimeters	
	Area skin treated with ultraviolet	Control area of skin
Staphylococcus Toxin Injected Immediately Following Injection of Antitoxin		
1193	1.5×2.0	2.0×3.0
1194	0.5×0.5	2.5×2.5
Staphylococcus Toxin Injected 2 Hours Following Injection of Antitoxin		
1216	2.0×2.0	1.0×1.0
1217	0.5×0.5	1.5×1.5
1218	No Necrosis	1.5×1.5
Staphylococcus Toxin Injected 24 Hours Following Injection of Antitoxin		
1138	No Necrosis	0.1×0.2
1139	No Necrosis	1.0×2.0
1140	No Necrosis	1.0×2.0
1141	No Necrosis	1.0×1.0
1142	No Necrosis	2.0×3.0
1143	No Necrosis	2.0×1.5
1150	No Necrosis	0.5×0.5
1153	0.5×0.5	2.0×3.0
1154	No Necrosis	2.0×3.0
1156	No Necrosis	2.0×2.0
1179	No Necrosis	2.0×2.0
1182	No Necrosis	1.0×1.5
1183	No Necrosis	0.5×0.5
Staphylococcus Toxin Injected 5 Days Following Injection of Antitoxin		
1144	2.0×2.0	2.0×3.0
1145	1.5×2.0	2.0×3.0
1177	0.5×0.5	1.5×1.5
1178	1.5×2.0	1.0×7.0
1180	1.0×1.0	1.0×1.0

Rabbit No.	Size of Necrosis in Centimeters	
	Area skin treated with ultraviolet	Control area of skin
Skin Treated with Ultraviolet and Toxin Injected Immediately. No Antitoxin		
1201	2.5×3.0	2.5×3.0
1202	2.0×0.4	2.5×3.0
1200	1.0×5.0	1.5×5.0
1206	1.5×4.0	2.0×4.0
1207	2.5×3.0	1.5×6.0
Skin Treated with Ultraviolet and Toxin Injected 2 Hours Later. No Antitoxin		
1210	2.0×3.0	2.0×3.0
1211	1.0×3.0	1.0×3.0
1212	1.0×5.0	1.5×3.0
Skin Treated with Ultraviolet and Toxin Injected 24 Hours Later. No Antitoxin		
1152	2.5×4.0	2.0×3.0
1157	2.0×2.5	2.5×5.0
1158	1.5×2.0	2.0×3.0
1159	1.0×2.0	2.0×4.0
1167	1.0×1.0	2.5×2.0
1168	2.0×3.0	2.5×5.0
1169	1.5×3.0	2.5×4.0
1170	1.0×1.0	2.0×5.0
Staphylococcus Toxin Injected in Area Treated Immediately with Ultraviolet		
1195	2.0×2.0	2.0×2.0
1196	2.5×3.0	2.5×3.0
1197	2.0×2.0	2.0×2.0
1198	0.5×0.5	2.0×2.5
1199	1.5×2.0	2.0×2.0
1200	2.0×5.0	2.0×5.0

Lesions usually recorded after 24 hours; however, some observations made as long as 5 days following injection of toxin.

jected into the marginal vein of the ear. Staphylococcus toxin (0.2 cc.) was then injected into both the irradiated and non-irradiated skin. Necrosis occurred in both areas; however, the size of the necrosis in the ultraviolet area of skin was smaller than the necrosis in the normal skin (Table 1, No. 1193 and 1194).

Three rabbits were given 5.0 cc. of staphylococcus antitoxin immediately following ultraviolet irradiation and staphylococcus toxin was then injected intradermally two hours later. This procedure was carried out since it may require an interval for a sufficient amount of antitoxin to localize in the ultraviolet treated area of skin to completely inhibit the necrosis. In the ultraviolet treated area of each of these

rabbits (No. 1216, 1217 and 1218) the necrosis was greatly decreased in size when compared with the controls.

The skin of 13 rabbits was irradiated with ultraviolet light and 5.0 cc. of staphylococcus antitoxin was injected intravenously. Twenty-four hours later 0.2 cc. of staphylococcus toxin was injected into the treated and untreated skin. The data in Table 1 show that necrosis occurred in the untreated skin of each of these rabbits. However, in only 1 of these animals did necrosis occur in the ultraviolet treated area. Figure 1 illustrates this inhibition of necrosis in the ultraviolet treated area following the injection of staphylococcus toxin.

The above observations indicate that staphylococcus antitoxin localizes and concentrates in areas of skin treated with ultraviolet radiation. It is necessary, however, for an interval of approximately two hours to elapse before a sufficient amount of antitoxin can concentrate to markedly

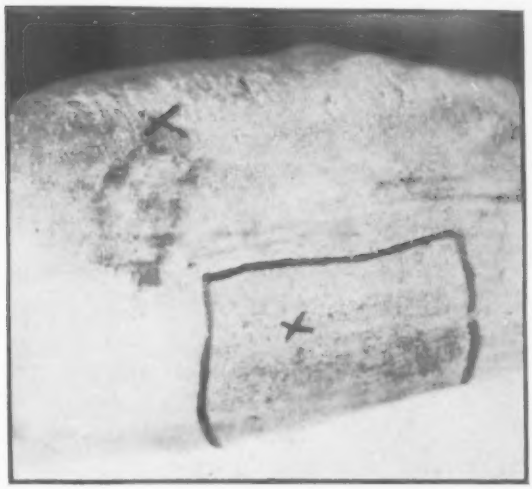

Fig. 1. R 1154. Ultraviolet radiation was applied to the skin outlined by india ink for ten minutes at a distance of 10 inches; 5.0 cc. of staphylococcus antitoxin was given intravenously. Twenty-four hours later 0.2 cc. of staphylococcus toxin was injected below the *X* in the treated and in the untreated skin. Necrosis occurred in the untreated skin. There is no necrosis in the area treated with ultraviolet radiation. Photograph taken twenty-four hours following the injection of the staphylococcus toxin.

Fig. 2. R 1145. This rabbit was treated the same as the one shown in Figure 1 except the staphylococcus toxin was injected five days following the injection of the antitoxin. Necrosis is present in both the treated and untreated area; however, it is smaller in the former. The amount of antitoxin apparently begins to decrease about the fifth day. Photograph taken twenty-four hours following the injection of the staphylococcus toxin.

inhibit the necrosis produced by the amount of toxin used in this experiment. Within a period of twenty-four hours a sufficient quantity of antitoxin has localized to completely inhibit the necrosis produced by the toxin as used in this experiment. A group of 5 rabbits was used to determine the length of time in which the antitoxin may remain in the ultraviolet treated area in a quantity sufficient to completely inhibit necrosis. These rabbits were given the ultraviolet radiation and the toxin was injected intradermally. Necrosis occurred in both the treated and untreated areas of skin; however, the areas of necrosis were usually smaller in the ultraviolet treated areas of skin than they were in the controls as shown in Table 1 (Fig. 2).

Effect of Staphylococcus Toxin on Skin Previously Treated with Ultraviolet Radiation

A group of 6 rabbits was used to observe the direct effect that ultraviolet radiation may have on the skin when staphylococcus

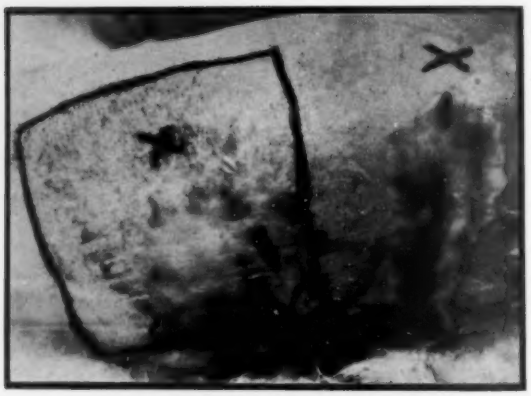

FIG. 3. R 1195. Two areas of skin were each injected intradermally with 0.2 cc. of staphylococcus toxin. The area outlined with india ink was treated immediately thereafter with ultraviolet radiation for seven minutes at a distance of 10 inches. Necrosis occurred in both areas. Photograph taken five days following the injection of the toxin.

toxin is subsequently injected intradermally. The skin of these rabbits was irradiated with ultraviolet light for seven minutes and staphylococcus toxin was injected intradermally immediately thereafter in the treated and untreated areas of skin. Necrosis occurred in both areas of skin as shown in Table 1. There was a smaller amount of necrosis in the ultraviolet treated area of some of the rabbits than there was in the control. These rabbits showed large areas of edema inferior to the irradiated area and below the site of injection of the toxin. It appears that the toxin filters downward in the edema fluid. The diminution in size of the necrosis in the two areas may be explained by the presence of this edema.

For an adequate control of the experiment where staphylococcus antitoxin and ultraviolet radiation were used and staphylococcus toxin was injected two hours later, 3 rabbits were treated with ultraviolet radiation and staphylococcus toxin was injected intradermally two hours later. Necrosis occurred in both areas. Eight rabbits were treated similarly with ultraviolet radiation and twenty-four hours later staphylococcus toxin was injected intradermally. Necrosis occurred in both the treated and untreated areas of skin as shown in Table 1.

EFFECT OF ULTRAVIOLET RADIATION ON STAPHYLOCOCCUS TOXIN IN VIVO

The result of the preceding experiments suggests that staphylococcus antitoxin localizes and concentrates in areas of skin previously treated with ultraviolet radiation. There apparently is insufficient evidence from these experiments to indicate that the skin becomes more resistant to the effects of staphylococcus toxin following ultraviolet irradiation. However, to study the direct effect that ultraviolet radiation may have on staphylococcus toxin 6 rabbits were used. Staphylococcus toxin (0.1 cc.) was injected into two areas of the skin. Ultraviolet radiation was immediately applied over one of these areas for seven minutes. The second area was kept as the control. Necrosis occurred in both areas (Fig. 3). There was no indication from this experiment that ultraviolet radiation as used here has any effect on the action of staphylococcus toxin on the rabbit's skin.

DISCUSSION

The experiment shows that there is an absence of necrosis following an intradermal injection of staphylococcus toxin in those areas of skin where ultraviolet radiation is applied and staphylococcus antitoxin is given intravenously. This inhibition of local necrosis apparently results primarily from the neutralization of the toxin by the antitoxin. Staphylococcus antitoxin apparently accumulates in a greater quantity in the inflamed tissue than in the normal skin as shown by the absence of necrosis in the ultraviolet treated areas. The presence and the absence of necrosis in the skin of the same rabbit is a good control and eliminates the necessity of determining the variation in the normal staphylococcus antitoxin titer of each animal.

A diminution in the size of the areas of necrosis in the ultraviolet treated areas as compared with the necrosis that occurs in

the untreated skin indicates that factors other than antitoxin may play some rôle in this process. It appears likely that the edema which is present in the ultraviolet treated areas of the skin may dilute the toxin and, furthermore, the toxin appears to filter down from the site of injection and produce necrosis in the skin of the lower abdomen. Some of the toxin may be removed from the site of inoculation in the ultraviolet treated areas of skin as a result of an increase in the flow of lymph and blood. It is essential to inject the same quantity of toxin into the ultraviolet treated area of skin in rabbits given antitoxin as is necessary to produce definite areas of necrosis in the ultraviolet treated areas of skin in other rabbits without the addition of antitoxin.

A diminution in the size of the necrosis in the ultraviolet treated areas of skin in these rabbits is similar to the results observed when xylol was applied to the skin of rabbits and staphylococcus toxin was subsequently injected.[8] In the latter experiment the amount of antitoxin apparently was decreased after five days and after nine days the same size of necrosis occurred in the xylol treated skin following the intradermal injection of toxin as occurred in the untreated skin. The presence of necrosis in some of the areas of skin inferior to the area treated with ultraviolet radiation suggest that a change may occur in the skin following ultraviolet irradiation that inhibits the union of staphylococcus toxin with the tissue cells; however, there is insufficient evidence in these experiments to prove this point. Such a phenomenon has been observed, however, in rabbits when a hypertonic solution of sodium chloride was injected intradermally preceding the intradermal injection of staphylococcus toxin.[4] The results obtained in this experiment suggest that ultraviolet radiation, as used here, has no direct effect on the action of staphylococcus toxin on the skin of the rabbit.

It would appear most likely from this study that staphylococcus antitoxin localizes and concentrates in areas of skin treated with ultraviolet radiation as a result of a change in the permeability of the cells. The mechanism by which this increase in permeability occurs is apparently not well understood. It has been suggested that the "so called increase in capillary permeability" accompanying inflammation represents a disturbance in the metabolism of all the cells in the area and not only a change in the endothelial cells of the small blood vessels.[9] As a result of this change in the metabolism of the cells antibodies pass through the endothelial cells of the capillaries at a faster rate than normal and either enter the cytoplasm of the extravascular cells or remain in the extracellular fluid. It has been shown that the localization of substances such as bacteria, colloidal dye and particles of India ink following an intravenous injection, is not determined by either the presence or the absence of hyperemia and edema.[7] Trypan blue may localize and concentrate in areas of rabbits' skin treated with roentgen rays when there is no evidence of either macroscopic or microscopic inflammation.[10]

The concentration of antibodies in areas of inflammation may produce a local condition unfavorable for the development of an infectious process. Recently such a condition was thought to occur in mice passively immunized with staphylococcus antitoxin when they were given a subcutaneous injection of broth culture of staphylococci. There was a marked increase in the number of leukocytes in the area of inflammation in the immune animals as compared with the number of leukocytes in the normal.[6] It is conceivable that antibodies other than antitoxin may localize and concentrate in areas of inflammation provided there is an increase in capillary permeability. The favorable results obtained clinically by irradiation and counterirritants on local areas of inflammation produced by bacteria may be influenced by the localization of antibodies in the areas as a result of a local increase in capillary permeability.

SUMMARY

Ultraviolet radiation, when applied to the skin of the rabbit in a quantity sufficient to produce an erythema, produces a local change in the skin whereby staphylococcus antitoxin will localize and concentrate in the area.

The presence of staphylococcus antitoxin in the ultraviolet treated area of skin is indicated by the absence of necrosis when staphylococcus toxin is injected intradermally and necrosis occurs in the untreated skin of the same animal.

Ultraviolet radiation apparently produces a change in the permeability of the cells in the local areas and as a result of this change the antitoxin concentrates in the tissue.

The significance of a concentration of staphylococcus antitoxin in the presence of an infection is briefly discussed.

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Twenty-eighth Annual Meeting: 1943, cancelled.

EDITORIALS

NEWER PHASES OF CANCER RESEARCH AND RADIATION THERAPY

OUR ideas concerning the treatment of cancer by irradiation have from time to time undergone important changes. There was, on the one hand, a continuously progressive therapeutic armamentarium, inherent in the technical developments of the time, and on the other repeated, always gratefully received, incursions from investigative minds of the allied sciences, who often found the radiologic terrain fertile and rich in prospects.

It is therefore not a singular coincidence that during the last few years notable contributions, especially from the domain of cancer research, have again started to exercise marked influence on our thinking and that some of these should already have produced noteworthy changes in our radiotherapeutic procedures. A very good example in this respect is the discovery of a definite relationship between the sex hormones and certain types of cancer of the genitalia as so masterfully expounded by Rhoads[1] in the Caldwell Lecture of 1942 before the American Roentgen Ray Society. And there are others. Since a knowledge of such contributions might help to better evaluate radiosensitivity, and thus irradiation criteria, their review here may not appear out of place.

By coordinating the wealth of experimental material available, Rhoads briefly established the following facts as pertinent. In certain pure strains of mice there is a hereditary susceptibility to breast cancer transmitted by the maternal parent. If the offspring of such mice are foster-nursed within twenty-four hours after birth on mothers of low cancer strain, cancer of the breast develops rarely, despite the heredity, although conversely the cancer incidence is raised from 0 to only 15 per cent. In the presence of both the hereditary and milk factors, the rhythmic ovarian secretion (estrogen) is responsible for the actual causation of the breast cancer and the anterior lobe of the pituitary gland exercises its well known rôle of controlling agent of the ovary. The implications of this estrogenic theory on the general clinical considerations and on the roentgen therapeutic indications of breast cancer in the human were stressed in a former editorial in this JOURNAL.[2] There is evidence accumulating that cancer of the uterus and ovaries develops on a similar basis and that thus the estrogenic theory may be extended to all cancers of the female genitalia. It is interesting in this respect that Heyman, Reuterwall and Benner[3] in carefully studying by means of multiple biopsies all cases of cancer of the female genitalia at the Radiumhemmet in Stockholm, found between 1914 and 1940 inclusive no less than 172 cases of simultaneous involvement of the corpus and collum uteri, 68 cases of the uterus and ovary and 11 cases of the uterus and several pelvic organs.

In one of the most important contributions to medical science of late, Huggins and Clark[4] and Huggins and Hodges[5] were

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[5] Huggins, C., and Hodges, C. V. Studies on prostatic cancer. I. Effect of castration, of estrogen and of androgen injection on serum phosphatases in metastatic carcinoma of the prostate. *Cancer Research*, 1941, *1*, 293–297.

able to demonstrate that the sex hormones play a paramount rôle also in some types of male cancers, notably those in connection with the prostate gland. As a result of exhaustive work and most ingenious experimental techniques, these authors have proved that androgenic substances stimulate and estrogenic substances depress the secretion of the prostate gland. Likewise, if the gland is involved by carcinoma, an acceleration or retardation of the rate of growth of the carcinoma is noted, not only in its primary location, but in all its metastatic manifestations. Total castration produces an effect similar to that of the administration of the estrogenic substances. Although the chain of these investigations is still incomplete, the experiences gained here, too, have led to marked change in our conception of the treatment by irradiation.

Recently Berrill,[6] after a scrupulous analysis of a large number of significant articles collected from the literature, tried to harmonize the experimental evidence gained from a variety of other cancerogenic agents and thus to establish the different factors which may influence the malignant quality of a cell in general.

According to the evidence found, there is a multiplicity of factors responsible for the control and organization of the growth and multiplication of cells in an organism. Singular theories, such as the electrodynamic theory of Burr and Northrop or the recent metabolic gradient theory of Child, have found no ready acceptance.

One of the factors is represented by what one may call tissue compatibility. In this respect certain observations made on simple organisms are worthy of mention. Thus fragments of *Hydra*, placed more or less in contact, slide into positions so that each piece reoccupies approximately its original level in the organism as a whole, while in everted hydras, the cells of the inner and outer layers slide between one another to regain their proper respective positions. Dissociated sponge tissues display similar phenomena. This indicates that homologous cells and tissues from the same species mutually adhere whenever the environment is proper. Such tissue compatibility has also been observed in the higher organisms. It is an established fact, for example, that cancer grafts in a certain strain of mice lead to practically 100 per cent takes, whereas grafts of the same cancer in another strain of mice produce no, or very few, takes. Another type of tumor, originating in the reticulo-endothelial system of mice, was found by Barnes and Furth to yield 100 per cent takes in the ancestral leukemic stock and no takes whatever in the ancestral non-leukemic stock.

In Berrill's view, if the malignant character of cells is the result of disruption of the growth controlling and organizing forces, it is improbable that one cell should alone escape from the control. Multiple foci should occur frequently and in various locations. This view has found confirmation, as already stated, in the sex hormonal cancers of the genitalia, especially in the female.

Another factor is the response of the cell to tissue extracts. Berrill found considerable proof that this response is very much along the same line as the response to the circulating hormones. There is an immediate increase of proliferation of the cells sensitive to the inducting extract but the histogenesis remains a function characteristic of the intrinsic nature of the cell and not of the extrinsic factor. The response is often quite general. For example, sex hormone accelerates and intensifies the breakdown and ossification of growing cartilage whereas thyroid secretion increases proliferation and differentiation, with retarded ossification, of the same tissue. But the most striking examples of histogenetic response are observed from the effect of cell-free extracts of malignant tissue. Berrill cites the observations of Rous, Murphy and Tytler, Muto, and Furth and Breedis, who found that extracts of chondrosarcomas and osteochondrosarcomas of the fowl transmit their specific histology as well as malig-

[6] Berrill, N. J. Malignancy in relation to organization and differentiation. *Physiol. Rev.*, 1943, *23*, 101–123.

nancy, of Parsons who noted the same condition to be true in mice and of Lucke and of Briggs who demonstrated specific tumor induction although with less certainty in the frog. Many other similar observations were made. In all these there seemed to be a relative sensitivity to the extracts of those cells which were less specialized and most closely related to the tumor tissue from which the extracts were made. As already stated, such behavior strongly suggests a parallelism with the circulating hormones of the endocrine system.

This parallelism manifests itself also in another direction. As is known, sex hormones can induce blending of tissues in the early stages of development but not after full maturity has been reached. In a like manner, Rous's fowl sarcoma extract, which is ineffective in ducks, can produce malignant disease in ducklings within a day or two after hatching. Moreover, the newly induced process was found to affect the epithelial tissues and only to a lesser extent the mesenchymatous tissues, whereas in the fowl, these latter constituted the sole system involved.

Other factors inducing malignancy of a cell are polycyclic hydrocarbons, butter yellow, arsenic, viruses, radiations, etc.

It is Berrill's contention that in relation to chemical agents there may be much more than an analogy between the induction of a malignant tumor and the induction of divisions in eggs by parthogenetic chemicals. It is known that most effective parthogenesis occurs from surface active compounds such as oxybutyric acid, and that profound changes in the egg cortex are observed immediately after their application. In a like manner, there is evidence that the division of normal cells is controlled by surface conditions and their relationship to one another. Polycyclic hydrocarbons, lipoids, sex hormones, avian tumor agents, etc., are like parthogenetic chemicals, surface active compounds and therefore they may be expected to affect the surface environment or cortical conditions of the cells leading to overthrow of the state of equilibrium with resulting uncontrolled proliferation. In this respect the theory of chemical inductors of specific structural type has given place to the nonspecific conception. Clowes, Davies and Krahl suggest, from studies of the interaction of polycyclic hydrocarbons and steroids in surface films, that the interfacial forces may be strong enough to permit the hydrocarbons of the cells to influence the metabolism of cholesterol and other sterols producing permanently injured surface relationship, which then acts as the disruption agent. It is significant in this respect that tumor cells have a higher lipoid content than most other cells, confined chiefly to the surface layers of the cellular structures. But lipoids also form a major constituent of mitochondria and, as is known, carcinogenic hydrocarbons have a selective affinity for these bodies. It is conceivable, therefore, that hydrocarbons act in two ways, either by changing through the interfacial forces the surface relationship of a cell or by altering its general steroid metabolism with abnormal chromosome distribution as the final result. The steroids themselves, as for example the estrogen, induce malignant changes in a similar manner in estrogen compatible tissue.

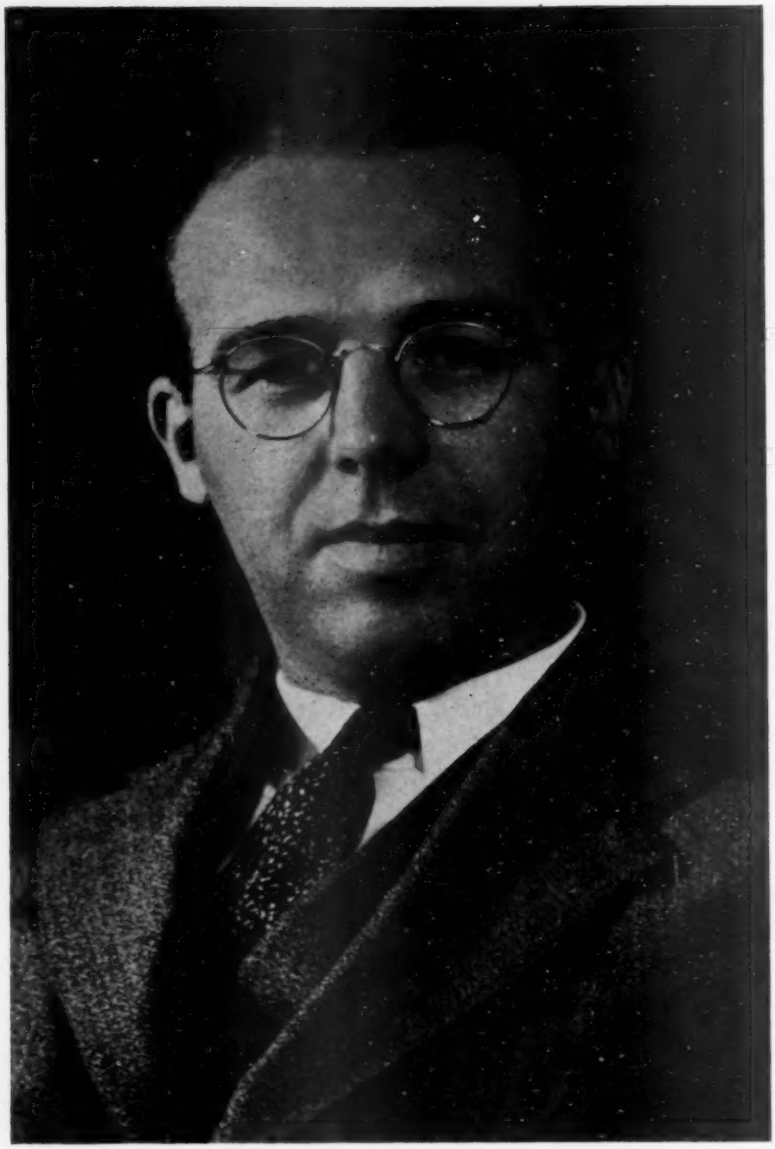
In the material reviewed by Berrill, it appears that the action on the nucleus is primary only in connection with the effect of the radiations, as, for example, ultraviolet rays, roentgen rays or radium, whereas with the effect of most chemicals it is secondary. In both instances, depending on the magnitude of the effect, chromosomal aberrations or total nuclear destruction are observed. The chromosomal aberrations appeared as chromosomal dislocations or gene mutations. In this respect it was found, for example, that carcinogenic cysticercus cysts induce chromosomal irregularities almost immediately upon application and long before there are any other manifestations of malignancy, although the mitoses continued to remain bipolar. In mice strains of high cancer susceptibility likewise a great tendency to chromosomal disturbance was noted

at the slightest provocation. The general effect of steroid carcinogens being that of retardation, the disturbed metabolism of the cell often leads to multipolar mitoses many months before the appearance of the actual tumor.

Although it does not follow from the data gathered by Berrill, there is now evidence accumulating that the effect of the radiations on the cells is not altogether through disruption of the nucleus or at least that the action on the surface relationship of the cytoplasm cannot be ignored. In a series of experiments, Reynolds, Corrigan, Hayden and Grikscheit demonstrated that roentgen rays are capable of breaking up molecules of simple solutions of protein, thus changing the osmotic pressure of the solution, the magnitude of the change being an accurately measurable property. Furthermore, since during the course of irradiation of such a complicated biological system as a cell, all component parts are bombarded simultaneously, one must surmise that the semipermeable membrane of the cytoplasm is also affected. Indeed, experiments have shown that lipoid substances will combine with protein monolayers into artificial membranes and that the penetration of fat-soluble or water-soluble substances through such membranes can easily be tested. Irradiation of such membranes leads to disturbance of transmission or complete disintegration. It is conceivable that the membranes of living cells which, in fact, are dynamic structural entities responsive to chemical and electrical stimuli, and not inert protective shells, react in a similar manner. Such a view explains not only the immediate injurious effect of the radiations on cells but also the cancerogenic effect in the long run.

All these studies are extremely interesting. Although for the present the conclusions may appear indecisive and somewhat speculative, time will gradually forge them into a strong chain of indisputable facts constituting the basis of our future knowledge in cancerology. The science of radiotherapeutics cannot be kept aloof from such a development.

T. Leucutia



Pavelle Laboratories, Inc.

CORNELIUS GYSBERT DYKE
1900-1943

DR. CORNELIUS GYSBERT DYKE, First Vice-President of the American Roentgen Ray Society and Associate Professor of Radiology of the College of Physicians and Surgeons, Columbia University, died on April 23, 1943, of acute leukemia. His death at the age of forty-two cut short a career marked by rich achievement.

Born in Orange City, Iowa, he attended Morningside College in Sioux City and later the State University of Iowa, where he received his degrees of B.S. and M.D. Following an internship at the Naval Hospital in Chelsea, Massachusetts, he was for two years resident in radiology at the Peter Bent Brigham Hospital in Boston. His in-

terest in the brain tumor collection there received further opportunity to develop from the appointment in 1929 to the Neurological Institute in New York, where he was first the assistant of Dr. Charles Wadsworth Schwartz and later the Director of the Department of Radiology. Three nights a week and alternate weekends spent in studying the material in this department furnished the foundation for many publications that are important source-papers today. Much of this work was in collaboration with Dr. Leo M. Davidoff. The bibliography at the end of his chapter on "Diseases of the Skull and Intracranial Contents" in Nelson's Loose Leaf Diagnostic Roentgenology lists many references to this material. His observation that spinal cord tumors produce changes in the interpedicular spaces in the spine has greatly advanced the diagnosis of those lesions. This JOURNAL for June, 1942, gives his account of the turning of the pathologist's observation of calcification and internal hydrocephalus in infection from toxoplasma to roentgen diagnostic account.

His demonstrations of exhibits and his instruction courses at the meetings of the American Roentgen Ray Society attracted wide interest. For all his prodigious capacity as a worker, he found time for his family and for good fellowship and friendship. His untimely death is deeply mourned by his colleagues, who accorded him their admiration and affection. He is survived by his wife and two sons; his parents, Mr. and Mrs. Charles Dyke of Orange City, Iowa, and a brother, Dr. Lester Dyke of Clinton City, Iowa.

RAMSAY SPILLMAN

CORNELIUS GYSBERT DYKE

The following tribute to Dr. Dyke by Dr. Leo M. Davidoff was given before the Harvey Cushing Society at its meeting in New York on May 8, 1943:

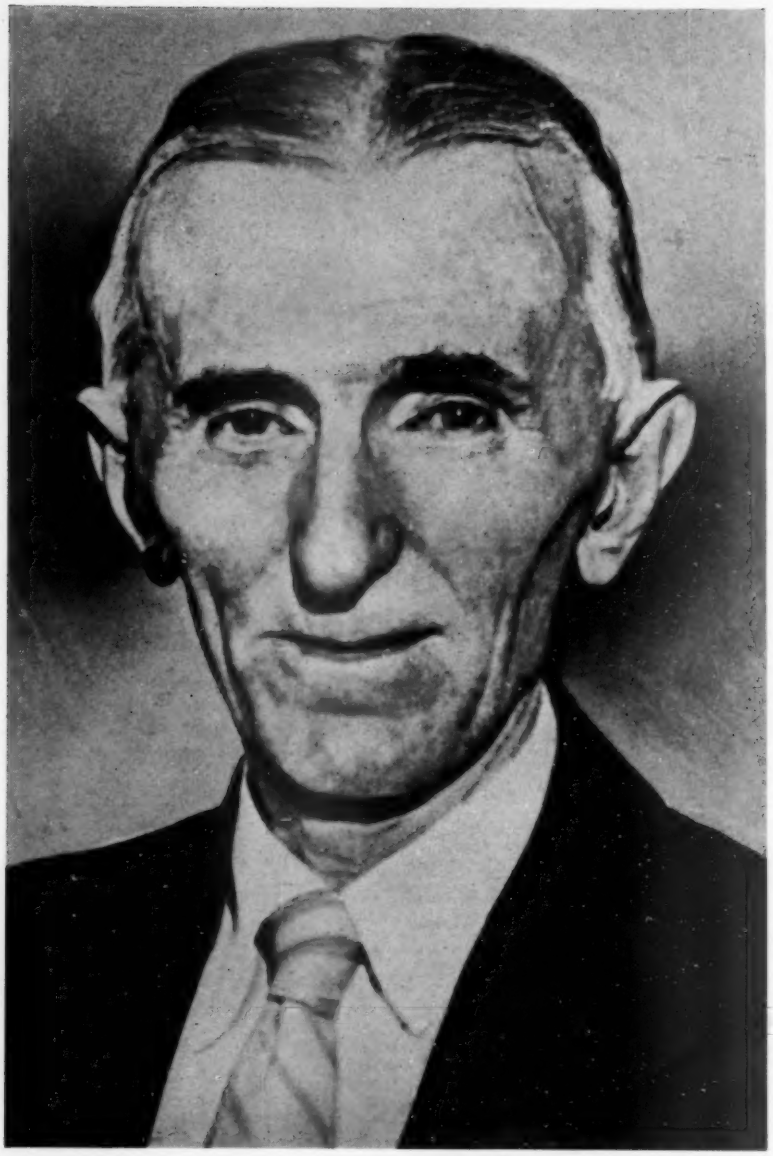
Except for the death of Dr. Cushing himself, this Society has only once before experienced the tragic loss of one of its active members until April 23rd of this year, when we witnessed the passing of Cornelius G. Dyke. It is only to be expected that in the course of time any group is bound to see a thinning in its ranks, but Cornelius was hardly ready for the processes of nature to take its toll of him.

He was only forty-two years old when he died after a relatively short illness. Everything about him was alive and vibrant. His outlook was always ahead into the future rather than into the past. And suddenly he was taken from among us—too startled to realize our loss.

You know the place he has made for himself in his special field of endeavor. It was not only that he had the extraordinary skill of every outstanding roentgenological diagnostician to see every tiny shadow in the film before him. He had in addition a thorough knowledge of neuro-anatomy, neuropathology, and clinical neurology. It was in recognition of these attainments that he was made a member of this Society—and at one time its president—as well as an associate member of the American Neurological Association.

On the personal side he was a staunch friend and possessed a shining honesty that blazed through superfluities to the heart of every matter he touched. He was judicious to the point where often older and more experienced colleagues sought his judgment. He was calm, self-possessed and patient so that he was one of the most instructive and popular teachers at both the medical school and hospital.

His untimely death has left a gap in our ranks and in our hearts that will not be closed easily.



Courtesy of the *New York Times*

NIKOLA TESLA
1856-1943

NIKOLA TESLA was found dead in bed in his room in the Hotel New Yorker, in New York City, on January 7, 1943.

Born July 10, 1856, in Serbia, Nikola Tesla at an early age showed signs of being an electrical genius. After attending the high school in Graz and the University of Prague, he became an engineer for the Budapest Telephone Company. In 1883 he entered the employ of the Continental Edison Company in Paris. In 1884 he came to the United States. After a short period with Thomas A. Edison he became a protege of

George Westinghouse, who saw eye to eye with him on the transmission of power in the form of alternating current. Later Tesla established himself as an inventor and consulting engineer. Many of his inventions went into the foundation of the electrical industry of the United States, but of the billions of dollars of wealth which he thus helped to create, he acquired relatively little. In an editorial following his death, the *New York Times* observed that Tesla's productive inventive career was from 1886 to 1903 and was of profound technical and economic consequence, after which period he devoted himself to projects which are looked upon now as Jules Verne's phantasies were regarded then. The most spectacular of these was a "death ray" in which he proposed to project electrical energy involving fifty million volts in a microscopically thin beam that would destroy all that came before it, and make the country in possession of it impregnable. This offer was made to the government on his eighty-fourth birthday, July 10, 1940, and involved a proposed development time of three months and an expenditure of two million dollars. However, government funds were not forthcoming and Tesla did not have the funds to develop the idea himself, so it will remain for the future to tell whether the idea might have been feasible.

Aside from the future confirmation of Nikola Tesla's later ideas, he was at the height of a career of recognized productivity when the Roentgen Society of the United States was organized in 1900. This society was the forerunner of the American Roentgen Ray Society, and Tesla was designated its first honorary member, on March 26, 1900. In the *American X-Ray Journal* for October, 1900, is reproduced a photograph showing Tesla seated reading amid a display of electrical sparks comparable in magnitude with the artificial lightning that awed visitors to the New York World's Fair forty years later. The photograph is inscribed "To the Roentgen Society of the United States, with good wishes for the success of its efforts from Nikola Tesla. New York Sept. 25, 1900."

Patents awarded to Tesla show that he had anticipated the essential elements of radio as early as 1893, and his claims of priority over Marconi involved long litigation.

Tesla never married. He is survived by six nieces and nephews, of whom four are in Yugo-Slavia and two in this country: Mr. Sava N. Kosanovich, New York, who is President of the Eastern and Central European Planning Board, and Mr. Nikola Trbojevich, Toledo, Ohio. Mr. Kosanovich stated that it would take years to examine and index the papers left by Tesla. His funeral was held in the Cathedral of St. John the Divine, and an impressive array of dignitaries did him honor.

Ramsay Spillman

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual Meeting: 1943, cancelled.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: 1943, cancelled.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Drake Hotel, Chicago, Ill., Nov. 29–Dec. 3, 1943.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. J. D. Coate, 434 Thirtieth St., Oakland, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION
Secretary, Dr. Donald R. Laing, 65 North Madison Ave., Pasadena, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. Warren W. Furey, 6844 S. Oglesby Ave., Chicago, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. J. O. Newton, 13921 Terrace Rd., East Cleveland. Meets at 6:30 P.M. at Midday Club on fourth Monday each month, October to April, inclusive.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Building.

FLORIDA RADIOLOGICAL SOCIETY
Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meeting held the second Sunday in May annually.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Hugh F. Hare, Lahey Clinic, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. H. J. Perlberg, 921 Bergen Ave., Jersey City. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. H. H. Kasabach, Presbyterian Hospital, New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

NORTH DAKOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Ohio Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati. Meets at time and place of annual meeting of Ohio State Medical Association.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. R. G. Alley, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Sidney Larson, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

St. Louis Society of Radiologists
Secretary, Dr. P. C. Schnoebelen, 462 N. Taylor Ave. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

San Francisco Radiological Society
Secretary, Dr. H. A. Hill, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months at Toland Hall, second at Lane Hall.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. Herman Klapproth, Sherman, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October throughMay, College Club, Seattle.

X-ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets monthly on third Thursday from November to June inclusive, at 8:15 P.M., 32 Welbeck St., London.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Canadian Association of Radiologists
Secretary, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton, Alberta.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Continental Europe

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

AMERICAN BOARD OF RADIOLOGY

In order to determine the time and place of the next examination of the American Board of Radiology it is requested that all those who contemplate applying for certification within the next year file their application immediately in order that the officers of the Board may determine whether it would be advisable to conduct an examination at the time of the meeting of the Radiological Society of North America.

B. R. KIRKLIN, *Secretary*

WASHINGTON STATE RADIOLOGICAL SOCIETY

At the May, 1943, meeting of the Washington State Radiological Society, Dr. F B. Exner, of Seattle, was re-elected *President;* Dr. Thomas Carlile, of Seattle, was elected *Secretary-Treasurer.* Meetings are held on the fourth Monday of the month from October through May, at the College Club, Seattle.

NEW YORK ROENTGEN SOCIETY

At a recent meeting of the New York Roentgen Society the following officers were elected for the coming year: *President,* Dr. Ross Golden, New York; *Vice-President,* Dr. Maurice M. Pomeranz, New York; *Secretary,* Dr. Haig H. Kasabach, New York; *Treasurer,* Dr. William H. Boone, New York; *member Executive Committee,* Dr. Roy D. Duckworth, White Plains, New York.

ERRATUM

In the article by Klein, Klein, Klein, and Newman on "An investigation into some practical aspects of roentgen-ray stereoptics" which appeared in the May, 1943, issue of the JOURNAL, page 682, the degree of M.D. followed the name of Allen T. Newman. This is incorrect; the degree should have been D.D.S.

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DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 103 Rutledge Ave.
Charleston, S. C.

OBLIQUE VIEWS IN ROENTGENOGRAPHY OF THE WRIST

By RAYMOND W. LEWIS, M.D.
Roentgenologist, Hospital for Special Surgery,
Formerly Hospital for Ruptured and Crippled
NEW YORK, NEW YORK

ALTHOUGH the inadequacy of roentgen examination of the wrist in postero-anterior and lateral projection only is widely known, the practice of limiting the examination to these two views is still all too common. Because of this, graphic presentation of the inefficiency of this procedure seems indicated.

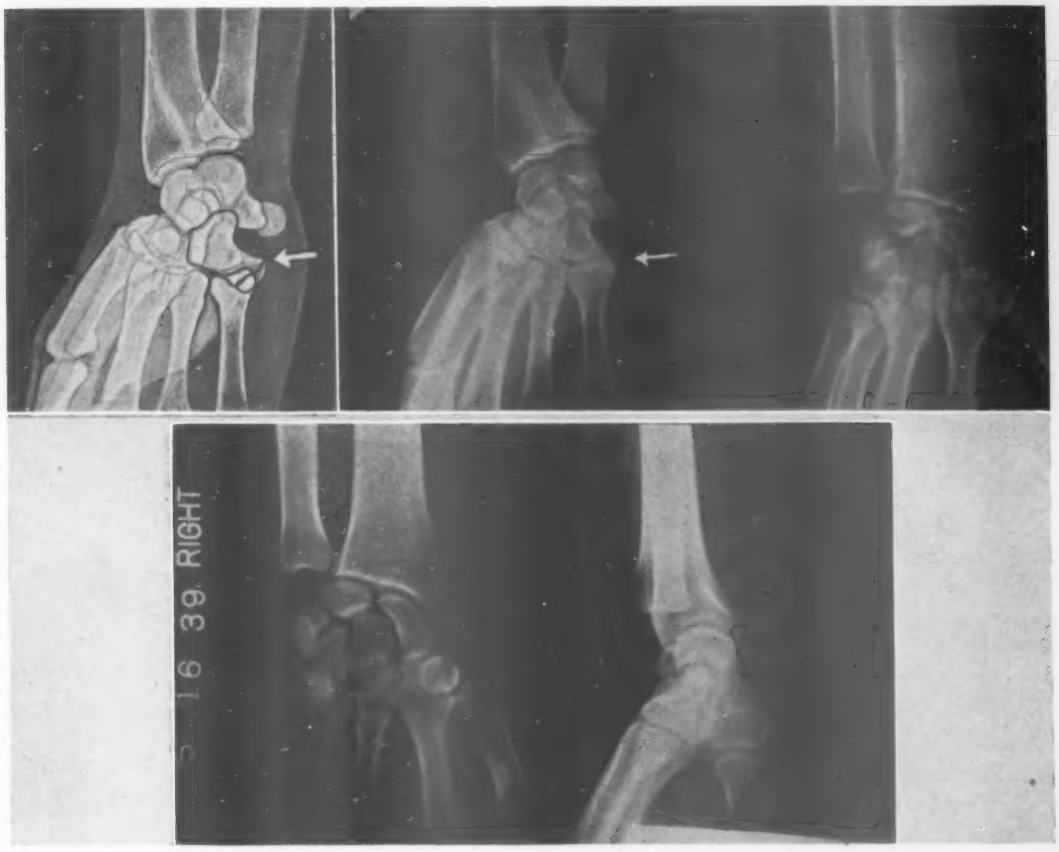

Fig. 1. Case iv. Fracture of the hamular process, shown in semisupine view only. Two such fractures have been diagnosed, and one case of involvement by disease of the hamular process.

FIG. 2. Case 1. Fracture of the radial styloid process, clearly visible in the semisupine view only. The pathologic change is scarcely perceptible in the other three projections, and they are not diagnostic. Many somewhat similar fractures of the lower extremity of the radius have been encountered, in which the diagnosis was dependent on the findings in one, or possibly two, of the four views.

Routine examination of the wrist should include four views: posteranterior, lateral, and the two obliques, semiprone and semisupine. This can be done conveniently by placing the four exposures on one 10 by 12 inch film. The additional cost in time and material is negligible, while the additional information obtained is very great. In occasional cases supplementary views may be needed, such as the posteroanterior projection with the hand in sharp ulnar deviation, which shows the navicular bone particularly well.

The small group of 5 traumatic cases (Fig. 1–5) is selected to illustrate how much pathologic change, shown not at all or inadequately in posteroanterior and lateral views, is well demonstrated by the oblique projections. These cases, though very few in number, are representative of a fairly large group of patients; none of these cases is unique, but each is one of several or many similar cases encountered.

SUMMARY

(1) Routine examination of the wrist should include four views: semiprone and semisupine obliques, in addition to the

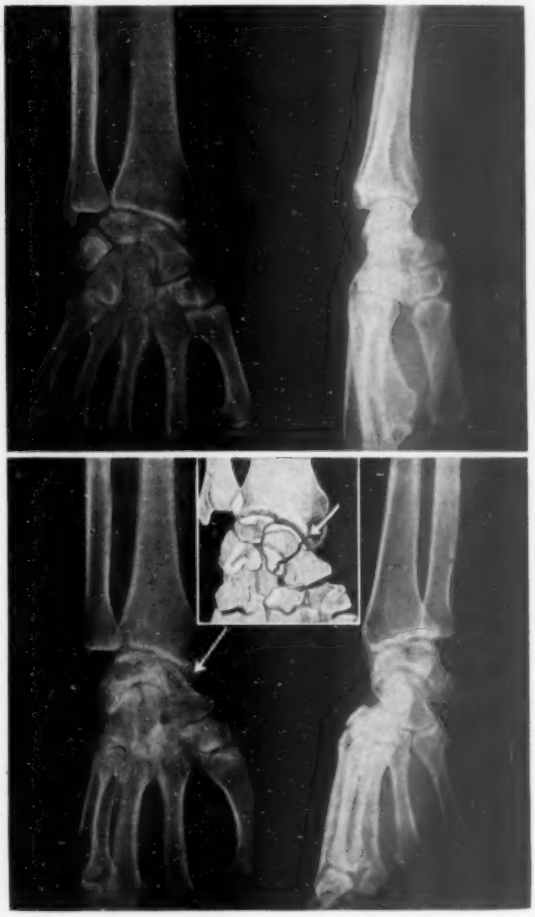

FIG. 3. Case 11. Fracture of the navicular, seen in semiprone projection only. Fractures of this bone are very common, and most are visible in the oblique views only.

Fig. 4. Case III. Comminuted fracture of the distal portion of the pisiform, visible in the semisupine projection only. Several cases of fractured pisiform have been seen, with the diagnosis impossible from the posteroanterior and lateral views alone.

posteroanterior and lateral projections. All four can be placed conveniently on one 10 by 12 inch film.

(2) Oblique views show much pathologic change either not visible at all, or inadequately shown, in posteroanterior and lateral projections.

Fig. 5. Case V. Chip or avulsion fracture of the posterior surface of the triquetral. Although the pathologic condition is clearly visible in the lateral view, the precise diagnosis can be made only from the information afforded by the semiprone projection. Many fractures of the triquetral cannot be seen or diagnosed accurately without oblique views.

(3) Five typical traumatic cases, representing a fairly large group of patients, are shown as evidence.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

NERVOUS SYSTEM

EDEN, KENNETH. The dumb-bell tumours of the spine. *Brit. J. Surg.*, April, 1941, *28*, 549–570.

The name refers only to the shape of the tumors and tells nothing of their pathology. In a series of 234 spinal tumors examined 32 were of the dumb-bell type; of these 25 were solitary or multiple neurofibromata, 3 were meningiomata, 2 were hemangio-endotheliomata, 1 was a ganglioneuroma and 1 was an endothelial cell sarcoma. Six cases are described and illustrated, and their mode of development discussed.

There are two main clinical types of dumb-bell tumor: those with paralysis from compression of the spinal cord and those without paralysis. If a spinal neurofibroma is removed and paralysis recurs or if after removal of a paravertebral tumor paralysis occurs, it suggests that part of a dumb-bell tumor has been overlooked.

Dumb-bell tumors are often overlooked on account of inadequate roentgen examination. The author criticizes the tendency to use lipiodol examination alone in spinal tumors and neglect ordinary roentgenography. An ordinary roentgenogram will show the bone erosion caused by dumb-bell tumor where it will be entirely overlooked on lipiodol examination.

Treatment depends on whether or not there is paralysis. If there is, laminectomy should be performed first in order to relieve it. If the paravertebral part of the tumor cannot be removed at the same operation it can be left until later. Information as to the size and position of the tumor is frequently furnished by the extent of the bone erosion on the roentgenograms and it may not be necessary to use lipiodol for localization. If there is no paralysis the paravertebral tumor may be removed first and then the intravertebral part removed by enlarging a foramen.—*Audrey G. Morgan.*

FALCONER, MURRAY A., and HOOPER, REGINALD S. Intramedullary epidermoid cyst of the spinal cord; report of a case with remarks on early diagnosis. *Brit. J. Surg.*, April, 1941, *28*, 538–548.

A case is described in a man of thirty-two, mechanic in an automobile factory. He came for examination complaining of gradually increasing stiffness and weakness of the left leg, for the past six months. There was no pain, no sensory disturbance and no loss of sphincter control. This suggested a diagnosis of amyotrophic lateral sclerosis. But lumbar puncture showed partial manometric block. The spinal fluid was normal. This demonstration of partial manometric block suggested tumor and a lipiodol test was made. The patient was put on a tilting table and tilted first with head and then with feet downward. The lipiodol showed a defect at the level of the second and third thoracic vertebrae. On operation the tumor was found at this site and microscopic examination showed it to be an epidermoid cyst. The patient regained normal use of his leg.

Only 9 cases of intramedullary epidermoid and dermoid cysts have been reported. The authors emphasize the importance of routine lumbar puncture and Queckenstedt's test in all cases with progressive spinal cord symptoms even if there are no sensory signs. This should be followed by lipiodol localization of the block. Because of failure to perform these tests doubtless other cases of tumor of the spinal cord have been mistakenly diagnosed as amyotrophic lateral sclerosis until sensory symptoms developed.—*Audrey G. Morgan.*

SKELETAL SYSTEM

KIRKLAND, GEORGE K. Leontiasis ossea. *Brit. J. Surg.*, July, 1941, *29*, 74–83.

Two cases of leontiasis ossea are described and illustrated with photographs and roentgenograms. The first was in a man of fifty-four with extreme enlargement of the bones of the skull and face, particularly the left maxilla. He also had spinal curvature with secondary osteoarthritis of the spine and multiple rodent ulcers, one on the leg. He was struck on the head with a stone when eight years of age but said he had no deformity of the head until 1923, though his record shows that he was rejected for army

service in 1915. The second patient was a woman of twenty-five first seen when nineteen years of age complaining of headache and pain in the eyes. She had had an injury of the head in a motorcycle accident when fourteen years of age and the headaches had begun two years later.

A comparison is made between this disease and Paget's disease. Some observers say they are the same but the author concludes that they are separate diseases. Leontiasis ossea generally begins in childhood or early youth and Paget's disease rarely before middle age. In Paget's disease the bones of the skull are most likely to be involved, in leontiasis those of the face. As a result, in Paget's disease the face is a triangle with the base upward, in leontiasis it is an irregular quadrilateral. In both cases described here there was increased blood phosphatase, which is seen in Paget's disease, but also in most bone tumors. The cases of leontiasis described have shown normal parathyroids. Mortimer has suggested that the disease may be caused by disturbance of the anterior pituitary and he has brought about sclerosis of the skull in rats by giving the ketogenic factor of the anterior lobe of the pituitary gland.

The characteristic change in leontiasis ossea is replacement of bone marrow by fibrous tissue and excessive formation of new bone in the fibrous tissue. Only 1 case of malignancy in leontiasis has been described, except for the rodent ulcers in Case 1 of this article. Of Paget's original 8 cases of osteitis deformans, 5 showed malignant disease, 2 of them carcinoma. Since then the malignancy reported in Paget's disease has been osteogenic sarcoma. Syphilis has been mentioned as a possible cause but most of the patients have had negative Wassermann reactions. Case 2 of this article had a positive Wassermann reaction but no history of syphilis. Both the patients had wide spacing between the eyes, suggestive of congenital syphilis.

As the etiology is unknown there is no logical treatment. In most cases all treatment, medical or surgical, has failed. The disease is slowly progressive and generally causes death in twenty or thirty years. Case 1 has had a history of forty-six years.—*Audrey G. Morgan.*

Evans, William A., Jr. Pathologic dislocations at the atlanto-axial joint: an unusual complication of rheumatic fever. *Radiology*, Sept., 1941, *37*, 347–350.

The author describes a case of rotary dislocation of the atlanto-axial joint in a boy nine years of age which occurred during an exacerbation of rheumatic fever. It was reduced by traction but there was a recurrence during another exacerbation of the fever. It was again reduced by traction and has not recurred in six months. There is free and painless motion of the neck in all directions, though a slight deformity remains. These pathologic dislocations of the atlanto-axial joint usually follow upper respiratory tract infections. This case occurring in rheumatic fever is unusual. The prognosis, unlike that in traumatic dislocations of this joint, is good. Stiffness and immobility of the neck comes on gradually but the head soon becomes fixed in a characteristic position, tilted slightly forward and downward with the chin pointed to one side. There is firm resistance when an attempt is made to bring the chin to the midline. On palpation at the back of the neck there is an unusual prominence of the spinous process of the axis. Palpation through the mouth shows prominence of the anterior arch of the atlas. A lateral roentgenogram shows the anterior arch of the atlas lying anterior to its normal position, while an anteroposterior roentgenogram taken through the mouth shows loss of spacing between the lateral mass of the atlas and the body of the axis on one side with overlapping of these structures. Treatment is prolonged traction and extension, usually with good results.—*Audrey G. Morgan.*

Mettier, Stacy R., and Capp, Charles S. Neurological symptoms and clinical findings in patients with cervical degenerative arthritis. *Ann. Int. Med.*, 1941, *14*, 1315–1322.

Thirty cases presenting clinical manifestations of pain and muscular stiffness about the neck and in the shoulder girdle, with radiation of pains down the arm or into the precordial region, have been analyzed. Seventeen of these showed definite evidence of "degenerative arthritis" of the cervical vertebrae, with narrowing of the intervertebral foramina because of ingrowth of marginal osteophytes and, in some instances, because of thinning of the intervertebral discs. It was theorized that the combination of these two processes probably accounted for impinging of nerve trunks as they pass through the involved foramina. It is suggested that changes incident to motor nerve damage are not prominent because of the

fact that anterior cervical roots are fewer in number and comprise only about one-third the size of the posterior sensory fibers.

Except for the 17 of this group of 30, there was no roentgen evidence of a pathologic condition sufficient to explain pressure changes. Clinically these other cases were identical with those which did manifest roentgen evidence and a preliminary swelling in the periosteum may occur without roentgen opacities.

The authors do not agree with Turner and Oppenheimer in their statement that narrowing of the intervertebral spaces is the common lesion. It is emphasized that the syndrome is of relatively frequent occurrence, though seldom diagnosed. The group of 30 patients considered in this report was seen during a period of less than three months. Many had wandered from one clinic to another in an endeavor to obtain relief. Most of the patients were between forty and sixty years of age (3 were less than forty). Their symptoms included pain, rigidity of the neck and muscular weakness of the hand or arm. The onset of pain was usually abrupt; it was frequently localized in or about the shoulder or it radiated down the arm and into the fingers. These symptoms usually appeared months or years before any complaints of neck discomfort. At times, the pains were sharp, jabbing, needle-like and penetrating or merely of a prickly or stinging feeling.

Importance of oblique studies of the cervical spine is mentioned and the fact that the sites of predilection are usually between the fifth and sixth or between the sixth and seventh vertebrae.—*A. A. de Lorimier.*

JENKINSON, E. L., and KINZER, R. E. Achondroplasia foetalis (chondrodystrophia foetalis). *Radiology*, Nov., 1941, *37*, 581–587.

Achondroplasia is a defect in ossification confined to bones that ossify in cartilage. It begins at a very early period in intrauterine life and is so severe that the fetus often dies before birth. The survivors are the dwarfs who are frequently seen. They have a large head, a trunk of normal length and short, thick extremities.

The authors describe 5 cases, 4 of them in Negroes, which is unusual. The disease is familial. The subjects are generally very intelligent. All dwarfs are not achondroplastics. Some of them have chondro-osteodystrophy and differentiation between the two diseases is difficult. The latter disease generally develops after birth, is rarely fatal and does not shorten life. The exostoses develop on the diaphyseal side of the epiphyseal line and extend away from the end of the bone, while in achondroplasia the change is confined to the epiphyseal cartilage. In achondroplasia the cells show a tendency to undisciplined growth in all directions while the cells of chondro-osteodystrophy are generally more regular.

These dwarfs may grow to maturity and the females may become pregnant, in which case the deformity of the pelvic bones may interfere with delivery.—*Audrey G. Morgan.*

SHAFAR, J. Hereditary short digits (with report of two cases of chondro-osteo-dystrophy). *Brit. J. Radiol.*, Dec., 1941, *14*, 396–402.

Two cases of abnormally short fingers and toes are described in two sisters, twenty-four and thirty-eight years of age. The hands and feet were short and squat as a result of the deformity which had existed throughout life, but manual dexterity was not affected. Both sisters also had limitation of movement of the hip joints due to arthritic changes. There was no involvement of the spine in these cases. The sisters were both short in stature. Another sister was said to be affected in the same way and both the mother and grandmother were short in stature and had the same condition of the digits.

Such cases are hereditary and probably caused by a transmissible abnormal gene, the transmission being of the mendelian dominant type. Many names are given to the condition but Brailsford's name of chondro-osteo-dystrophy is probably the most descriptive.—*Audrey G. Morgan.*

SHULMAN, SIMON. Rhomboid depression of the clavicle. *Radiology*, Oct., 1941, *37*, 489–490.

On the medial part of the lower surface of the clavicle there is a rhomboid depression somewhat more than 2 cm. long for the attachment of the costoclavicular ligament which passes from the rhomboid depression of the clavicle to the cartilage of the first rib. Ordinarily this depression is too shallow to be seen in the roentgenogram. But occasionally it is very deep, passing through about half the thickness of the clavicle. In such cases it may be mistaken for a pathological defect in the bone.

This deep rhomboid depression is usually

seen in very muscular males but the author describes a case seen in a boy of seventeen with only slight muscle development. He was examined for a bony mass felt just above the inner end of the left clavicle which proved to be a hypertrophied second rib. During the examination the unusually deep rhomboid depression was seen. The possibility of this anomaly should be remembered in order to avoid confusing it with a pathological lesion.—*Audrey G. Morgan.*

Bonnell, Fred H. A radiological consideration of intervertebral disc lesions. *Brit. J. Radiol.*, Dec., 1941, *14*, 386–391.

The normal anatomy of the intervertebral disc is reviewed. Congenital abnormalities vary from complete absence to changes occurring in gross anomalies of the vertebrae. In Klippel-Feil's syndrome the bodies of the second to sixth cervical vertebrae form a solid column of bone without any intervertebral discs.

In adult life the intervertebral disc is not subject to inflammation because of its nonvascularity. In the developing spine the endplates of cartilage are perforated by capillary vessels, but these disappear at about twenty years of age. In prolapse of the nucleus followed by the formation of granuloma there is temporary vascularization. At these times there is more possibility of infection.

Degenerative changes in old age are manifested first in the spinal column. Posterior prolapse of the nucleus is quite common but is not necessarily of clinical importance. It may cause low back pain and sciatica. In some cases with positive neurological findings operation has brought relief. The best way to demonstrate such prolapse is by the injection of 2 to 3 cc. of lipiodol and slowly tilting the patient's head downward. Roentgenograms of illustrative cases are given. Tumors of the disc are rare. No primary malignant tumors have been reported, though chondromata have been described.—*Audrey G. Morgan.*

Dunham, Charles L., and Kautz, Friedrich G. Spondylarthritis ankylopoietica. *Am. J. M. Sc.*, Feb., 1941, *201*, 232–250.

Spondylarthritis ankylopoietica is recognized as a definite clinical and pathological entity. This article is presented as a comprehensive review af the condition, describing the historical background concerned with its recognition, its pathology, the clinical picture, diagnostic considerations and treatment.

The authors' viewpoints are based upon a review of 2,395 patients registered at the Desert Sanatorium, of which 228 were diagnosed as having "atrophic arthritis;" 115, "hypertrophic arthritis," and 42, "spondylitis." Of the latter group, roentgenograms were available for 36 and of these, the authors considered the diagnosis to be "spondylarthritis ankylopoietica in 20 cases. These 20 cases are reported in tabular form.

Reference is made to Bechterew's spondylitis deformans and Strümpell's descriptions as well as those of Marie. The authors are noncommittal as to distinguishing separate groups with reference to reports by these early observers but it would seem that they are inclined to believe that Bechterew's spondylitis is not a pathological entity. This paper is especially concerned with distinguishing hypertropic spondylitis versus spondylarthritis ankylopoietica.

The latter condition is distinguished by changes in and about the pelvic girdle. Emphasis is given to the calcification of the sacroiliac joints; to the small intervertebral articulations, the early calcification of the ligamentum flavum, the deossification of the centra, and the sparing of the articular cortices and the discs. The authors believe that calcification of the ligaments should be considered a reparative process secondary to the loss of normal articular support of the spine.

As far as the clinical picture is concerned, the authors emphasize the involvement of the male sex, the age group (3rd and 4th decades), the background of acute or chronic infections or trauma to the spine, the background of acute polyarthritis and the intermittent character of actual symptoms. The patients usually manifest an absence of normal lumbar lordosis with a forward thrust of the upper trunk and head (producing a cervical and thoracic kyphosis). Thoracic excursions may be limited to the extent that the breathng is entirely diaphragmatic. There is likely to be emaciation with loss of muscle tone. Advanced cases may manifest hypersensitivities, rigidity and spasms or muscle atrophy. There may be a low grade fever, possibly a leukocytosis and anemia. During episodes of activity the sedimentation rate is almost invariably elevated. As complications, the authors emphasize the association

of pulmonary tuberculosis, iritis, pericarditis and pneumonia.

In the way of differential diagnosis, it is emphasized that whereas arthritis ankylopoietica is usually found in the third or fourth decades, hypertrophic arthritis of the spine usually occurs after the fourth decade (80 per cent). Moreover, the sedimentation rate is not elevated and fever and leukocytosis are uncommon to the latter. Roentgenographically, hypertrophic spondylitis is characterized by a degeneration of the intervertebral disc with narrowing of the spaces and with the formation of exostoses about the edges of the centra and more or less wedging of them. True bony bridging may occur but the changes in the costovertebral and posterior articulations as described above are not characteristic of the hypertrophic type. When ankylosis occurs, it is not generalized. Calcification of the sacroiliac joints can be expected in the majority of males by the fifth decade.

As for treatment, emphasis is laid on the importance of physical and mental rest, good nursing care, a high vitamin diet, ultraviolet irradiation, occupational therapy and correction of constipation. Warm and dry climate is recommended. Salicylates contribute to the well-being of the patient. The anemia might be corrected by iron, liver and even transfusions. Vaccines are considered uncertain as to benefit. Foci of infection should be eliminated. Orthopedic appliances may be indicated.

The prognosis is not good. This condition is usually slowly progressive, subject to remission and exacerbation, and gives the patient little peace until at the end of ten or twenty years bony ankylosis is established and there is cessation of pain.—*A. A. de Lorimier.*

DE SANTO, DOMINIC A., TENNANT, ROBERT, and ROSAHN, PAUL D. Synovial sarcomas in joints, bursae, and tendon sheaths. *Surg., Gynec. & Obst.*, June, 1941, *72*, 951–981.

Clinicopathological recognition of synovial tumors appears to have lagged behind that of other tumors. Reports of synoviomas are relatively rare but the authors are of the opinion that this type of tumor is not so rare.

This report deals particularly with 16 cases which have been studied in detail, together with 21 authentic cases reported in the literature.

In all instances, the tumors were found to arise from the synovium—of joints, of para-articular bursae or of tendon sheaths. Six were encapsulated (by way of para-articular walls); 6 were circumscribed (by way of intrabursal or surrounding tendon sheath limits), while 3 were diffuse (extending into joint recesses). Calcifications, chondrifications and ossifications were occasionally found.

The knee was involved in approximately half of the cases. Trauma was occasionally noted but did not seem to be an established etiological factor; neither did chronic bursitis, which was reported in a few of the cases for as long as ten years. In most instances, the tumors occurred between the twentieth and the fifty-fifth year. Approximately two-thirds occurred in males.

The symptoms included pain, tumor, joint dysfunction and occasionally fluid swelling. Pain was noted in only about half of the cases, though it was common to all of the knee cases where infiltrative tumors developed. The duration of the pain was from nine months to as long as ten years. Complaints of it were entirely absent or inconspicuous in the encapsulated or circumscribed para-articular tumors. Tumefaction was noted in 10 of the 16 cases, for from one month to ten years. Limitation of joint function was noted in approximately the same proportion. Diffuse intra-articular swellings occurred in only 2 of the cases.

Substantial roentgen evidence was noted in 10 of 13 cases so studied. Irregular calcifications were found in 6. Otherwise, the findings included soft tissue tumefactions (though 2 were missed at the first examination). The authors suggest that greater trust will likely be given the roentgen studies when more complete visualization of the soft tissues can be accomplished, possibly with the assistance of pneumoarthrography.

Because of the usual prolonged history and the encapsulation of the tumor, surgical treatment was too often conservative, consisting of local excision and delayed amputation. Recurrences occurred within a few months following local excisions, except for 2 cases. Eight of the 16 cases were treated with roentgen therapy, following local excision (regimen of treatment not described).

Cytological and histopathological characteristics are discussed. All synoviomas are considered malignant, though to varying degrees. The authors speculate on this matter suggesting that the greatest degree of malignancy can be prophesied for those showing densely packed, round, oval or reniform cells with abundant sup-

porting reticulum; the least malignancy for those showing a high degree of histiocytic differentiation with numerous multinucleated giant cells, pigmented cells and fibrous areas—such as seen in benign histiocytomas, though foam cells are more common to the latter, and intermediary between these two extremes, those tumors showing prominent endothelial characteristics with gland-like spaces.—*A. A. de Lorimier.*

Pomeranz, Maurice M., Friedmann, Lewis J., and Tunick, Isidore S. Roentgen findings in alkaptonuric ochronosis. *Radiology*, Sept., 1941, *37*, 295–303.

Alkaptonuria is a disease in which alkapton is excreted in the urine. This substance is a homogentisic acid produced by some rare metabolic disturbance which results in the urine turning black on exposure to air or on the addition of alkali. It also results in ochronosis or pigmentation of cartilages, tendons, ligaments and the intima of large vessels. These patients also frequently show swelling and deformity of one or more of the larger joints of the extremities or of the small joints of the hands, a condition which Osler called ochronotic arthritis.

The authors describe 2 cases in which this syndrome occurred. In one of them the diagnosis was made solely from the roentgenogram. Roentgenograms of a typical case show extensive calcification of the intervertebral discs with ankylosis of the spine. Similar calcifications may occur in tendon sheaths, bursal sacs and synovial membranes.—*Audrey G. Morgan.*

Brailsford, James F. Changes in bones, joints and soft tissues associated with disease or injury of the central nervous system. *Brit. J. Radiol.*, Oct., 1941, *14*, 320–328.

In addition to the arthropathies described by Charcot in tabes, syringomyelia and other diseases of the central nervous system there are other lesser joint changes associated with injuries of this system. A study of such cases by serial roentgenography has shown that the changes take place in four stages. (1) Hydroarthrosis. Any effusion of fluid into a joint following slight trauma should suggest an early arthropathy, particularly if there is little or no pain. This lack of pain is characteristic of these arthropathies throughout. This phase may last for two or three years and then, sometimes following further slight trauma, is succeeded by that of (2) disintegration. There is impaired stability and function of the limb and swelling and brawny edema of the soft tissues around the joint. Roentgen examination shows progressive wearing down of the joint surfaces with the deposition of calcium inside and outside the capsule and sometimes extending down along the shaft of the bone. This phase generally lasts three to six months and is followed by that of (3) hypertrophy. The swelling of the joint is now in the bone rather than the soft tissues. The joint is unduly mobile and its strength and stability are decreased. The roentgenogram shows progressive organization of the calcium deposits. This phase appears to last three to five years and is followed by that of (4) atrophy. The joint begins to show the atrophy of disuse. The muscles and soft tissues as well as the bones decrease in size and the limb becomes still weaker. The roentgenogram shows decrease in the size and density of the socket and of the end of the long bone. Roentgenograms illustrative of these different phases are given.

Fracture, sometimes comminuted, is often the first sign of neuropathic joint disease. Even with these fractures there is little or no pain.

The changes of traumatic myositis ossificans greatly resemble those just described and suggest that there may be a neuropathic factor in its causation. Both the clinical and roentgenographic appearances of neuropathic joint and myositis ossificans often resemble those of sarcoma and even the histopathological picture may be mistaken for that of sarcoma. Operation on such a diagnosis is most unfortunate as it furthers the development of ectopic bone. —*Audrey G. Morgan.*

deVries, J. K. The differential diagnosis of carcinoma of the prostate with skeletal metastases and osteitis deformans (Paget's disease of bone). *J. Urol.*, Nov., 1941, *46*, 981–996.

This study consists in a comparison of 42 cases of carcinoma of the prostate with skeletal metastases and 17 cases of Paget's disease. Carcinoma of the prostate with skeletal metastases was twice as frequent as Paget's disease in their experience. Both are diseases of later adult life.

Eighty-eight per cent of the cases of prostatic carcinoma in this study had symptoms of prostatic disease such as nocturia, hematuria, dysuria, urgency and incontinence. Only 20 per cent of the Paget's group had such symptoms. Pain was more constant, severe, and

progressive in the carcinoma group. The symptoms in the carcinoma group pointed toward the prostate and in the Paget's group toward some other condition than the Paget's disease.

A positive examination of carcinoma of the prostate could be made by digital rectal examination in 88 per cent of the cases studied. The essential feature in addition to enlargement of the gland was a change in consistency varying from firmness to hardness. Experience is necessary to rule out benign prostatic hypertrophy. In this series digital examination of the prostate was negative for cancer in 100 per cent of the Paget's group.

In addition to rectal palpation the diagnosis of prostatic carcinoma is aided by cystoscopy, excretory urography and cystourethrography. Lengthening, narrowing and straightening of the urethra is almost diagnostic of prostatic carcinoma in the opinion of the author. Pathological examination of tissue removed transurethrally for relief of obstruction will confirm the diagnosis. The most accurate method is biopsy following surgical exposure of the prostate through the perineum.

By roentgen examination it is usually possible to make the differential diagnosis. Films should be exposed of the pelvis, spine, skull and long bones. Paget's disease is more prone to involve the skull. In the author's series rib involvement was found in 10 cases of prostatic carcinoma and in no cases of Paget's disease. In Paget's disease the pelvic bones are thickened and coarse trabeculations stand out prominently; the femurs show marked thickening, decrease in the marrow cavity and bowing; the skull tables are markedly thickened and show patchy areas of increased density. In metastatic bone lesions from carcinoma of the prostate trabeculations are not visible; the bones have a spotty appearance due to areas of lesser and greater density; there is no bowing of the long bones and no cortical thickening. In the author's series 27 cases of prostatic carcinoma had metastases of the osteoplastic type, 8 of the osteolytic and 5 mixed.

Recent work indicates that serum "acid" phosphatase is high in bone metastases from prostatic carcinoma in contradistinction to elevation of the "alkaline" phosphatase in Paget's disease. The authors are studying this problem.

In the entire series by use of these various methods a differential diagnosis could be made in all but three cases out of the total of 59.

Finally it should be remembered that great difficulty will be experienced in an occasional case and also that the two conditions may be coexistent.—*R. M. Harvey.*

SWEET, L. K., and ABRAMSON, D. J. Multiple cystic tuberculosis of the long bones. *J. Pediat.*, Dec., 1941, *19*, 826–832.

Cystic tuberculosis may affect the long or the flat bones. In the long bones it usually occurs in the diaphysis. Solitary cysts are the rule, multiple cysts occur occasionally. Osteitis tuberculosa multiplex cystoides, as described by Jüngling, produces lesions which are solid but appear cystic on the roentgenogram. No caseation occurs and no tubercle bacilli are found on section. This is a separate entity from cystic tuberculosis.

The differential points between cystic tuberculosis and the type described by Jüngling are as follows: (1) the tuberculin test is negative in Jüngling's type and positive in cystic tuberculosis; (2) Jüngling's type usually involves the short long bones, the cystic type the long long bones; (3) the rarefied areas in the Jüngling type show no sclerosing reaction and no periostitis such as occurs in the cystic type; (4) sinus formation occurs in the cystic type and not in the Jüngling type; (5) skin lesions such as lupus pernio are found in the Jüngling type and pulmonary tuberculosis in the cystic type; (6) in the cystic type guinea pig inoculations are positive and negative in Jüngling's type, and (7) both show slow healing tendencies.

The authors thus feel justified in making a separate classification of the two entities.

They include a case report of a three year old colored female whose roentgen films showed expansile cystic lesions of the shafts of the bones of each forearm with moderate periostitis. The chest film showed no evidence of tuberculosis. Tubercle bacilli were found on smear of the aspirated material from the forearms and the guinea pig inoculations confirmed the diagnosis. Sinus formation developed subsequently. This case should therefore be classified as cystic tuberculosis.—*R. M. Harvey.*

SEVERIN, ERIK. Arthorgrams of hip joints of children. *Surg., Gynec. & Obst.*, March, 1941, *72*, 601–604.

The author has compared arthrograms of the hips in children with casts made on stillborns, using cinnabar and celloidin—described as "cinnoiden."

The studies have identified a number of

landmarks concerned with the joint capsule and thereby, too, the limits of the acetabulum and of the head of the femur, both of which are radiotransparent because of their cartilage rather than bone structure. A sacculation of the capsule was found for a width of several millimeters, parallel to the site of insertion of it into the femoral neck. Superiorly, this sacculation was limited by a band of relative filling defect—the "orbicular zone." Superior and mesial to this zone, a larger chamber was revealed. At the very superior extremity of this chamber, a pointed filling defect presenting the appearance of a "ploughshare" was visualized. This was found to represent the projection of the superior rim of the acetabulum. Inferiorly, with respect to this same chamber, a second prominent filling defect was identified as being produced by the ligamentum teres. Above and below this filling defect, two secondary pouch-like extensions of joint space were visualized. The author describes the upper one as the "recessus dorsalis fossae acetabuli"; the lower one, as the "recessus ventralis fossae acetabuli."

The relationship of these several landmarks serves to indicate the position of the head of the femur and its ligamentum teres and thereby to distinguish congenital dislocations.—*A. A. de Lorimier.*

Burrows, H. Jackson. Coxa plana, with special reference to its pathology and kinship. *Brit. J. Surg.*, July, 1941, *29*, 23–36.

Logically the name coxa plana should mean any flattening of the head of the the femur, whatever its pathology. But the author uses it only as a synonym for the more ordinary name of osteochondritis juvenilis. This disease occurs at any time between two and eighteen years of age and three-fourths of the cases are in boys. The characteristic pathological change is areas of destruction in which the trabeculae have been destroyed and only débris remains. Later regeneration takes place from invasion of the necrotic areas by young connective tissue The débris may become calcified.

The most striking histopathological change in ordinary aseptic necrosis of bone is death of the marrow with preservation of the trabeculae. Later they may be destroyed by a process of "creeping substitution," that is, an ingrowth of young connective tissue. But in osteochondritis juvenilis destruction of the trabeculae takes place early.

Photomicrographs and roentgenograms are given showing a comparison between the findings in true osteochondritis juvenilis and a number of other conditions frequently confused with it. On the basis of both roentgenological and histopathological evidence of destruction of trabeculae, the author concludes that osteochondritis of the tarsal scaphoid bone (Köhler's disease), of the head of a metatarsal (Freiberg's disease) and of the semilunar bone (Kienböck's disease) are akin to coxa plana. From roentgenological evidence alone, no histopathological evidence being available, he thinks that osteochondritis of the primary center of the body of a vertebra (Calvé's disease) and osteochondritis juvenilis of the capitellum (Panner's disease) are probably related to coxa plana, but he has found no satisfactory evidence, either roentgenological or histopathological, of any relationship between other diseases said to be osteochondritis juvenilis, including generalized osteochondritis. and coxa plana.—*Audrey G. Morgan.*

Smith, Rodney. Osteitis of the metatarsal sesamoid including a report of a case of acute pyogenic osteomyelitis. *Brit. J. Surg.*, July, 1941, *29*, 19–22.

The chief disease that occurs in the metatarsal sesamoid bone is a chronic one with pain to which various names are applied. But only 2 authenticated cases of acute osteomyelitis have been reported in this bone. The author describes a third in a girl of thirteen who in April, 1940, bruised the sole of her left foot against a rock. Two months later she felt acute pain at the base of the big toe of her left foot; she had a severe sore throat and a temperature of 105° F. Roentgenograms of both feet showed nothing abnormal. A yellow blister appeared on the back of her left foot, which broke and discharged pus; the sinus was enlarged and drained and the child was allowed to return home. She began to have pain in the sole of her foot and a fluctuant swelling appeared between the middle of the shafts of the first and second metatarsals. This was incised and discharged pus.

When she came to the author at the end of September she was free of fever and had no pain but there were discharging sinuses on the dorsum and sole of the foot. The pus discharged from the sinuses showed a pure culture of *Staphylococcus aureus*. Roentgenograms taken on September 14 and 25 showed that the lateral sesamoid was completely detached and lying between the proximal ends of the 1st and 2nd

metatarsals. A little abscess had formed inside the bone and discharged spontaneously. There was some periostitis of the shaft of the first metatarsal against which the sesamoid bone was lying. On opening the sinus on the sole of the foot the necrosed sesamoid was found lying in a pocket of pus. The sinus on the dorsum of the foot connected with that on the sole. After removal of the bone, packing of the sinus track and immobilization of the foot and great toe for a month healing took place rapidly. The roentgenograms are reproduced.—*Audrey G. Morgan.*

BLOOD AND LYMPH SYSTEM

BAUER, GUNNAR. Venous thrombosis; early diagnosis with the aid of phlebography and abortive treatment with heparin. *Arch. Surg.*, Sept., 1941, *43*, 462–472.

It has been found that venous thrombosis can be cured with heparin if it is given in the very beginning of the process. Heretofore it has not been possible to make the diagnosis early enough, but this can be accomplished by phlebography. An incision is made exposing a superficial subcutaneous vein just back of the external malleolus and 20 cc. of a 35 per cent solution of abrodil is injected into the vein. A roentgenogram is made after about a minute. The deep veins of the leg will be shown by the opaque medium if they are normal, but if thrombosis has begun there will be filling defects.

Twenty-one cases were treated with heparin in the beginning of thrombosis. Doses of 100 mg. were given three times a day for three to five days. Medication can be stopped when pulse and temperature have become almost normal. All the patients were up and able to walk within a few days after treatment was stopped.

On the other hand, among 32 cases in which heparin was not given there were 2 deaths, the thrombosis continued to spread in 24 cases, pulmonary embolism occurred in 3 cases and pulmonary infarction in 8.

Even in cases which are not seen early enough for cure heparin prevents the spread of the thrombosis.—*Audrey G. Morgan.*

KEEN, J. A. The collateral venous circulation in a case of thrombosis of the inferior vena cava, and its embryological interpretation. *Brit. J. Surg.*, July, 1941, *29*, 105–114.

Complete obstruction of the inferior vena cava with establishment of a collateral circulation was discovered in a dissecting-room subject, a Negro male seventy-one years of age. The thrombus in the vena cava had become organized and calcified. The obliteration of the vena cava must have taken place gradually as a sudden blocking of both renal veins would have caused death.

A semi-diagrammatic sketch is given of the venous circulation found on the posterior abdominal wall and a fundamental ground plan of the embryonic venous circulation. The veins on the right side of the embryo become involved in the inferior vena cava but those on the left side may persist as small anastomotic vessels which may become dilated if necessary. This seems to have occurred in this case. Because of the comparative lack of compensation on the right side there was great varicosity of the veins of that leg while there was no varicosity in the left leg.—*Audrey G. Morgan.*

GENERAL

DANCIGER, J. A., and WARREN, J. W. Rhabdomyosarcoma; case report. *J. Pediat.*, Aug., 1941, *19*, 223–228.

This case is reported because of the rarity of the lesion in infancy, the rarity of the lesion in Negroes, and the unusual location and widespread metastases. The case was that of a colored male child, aged two, who had had a slowly growing tumor mass in the calf of the right leg since the age of six months. On admission the mass was the size of an orange, firm, not attached to the underlying bone and seemed to move with the movements of the gastrocnemius group of muscles. Roentgen examination of the chest showed metastatic nodules in the left lung field and an effusion in the right pleural cavity. Roentgen examination of the right leg showed a large soft tissue tumor mass with no evidence of bony involvement. The child died before surgery or radiation therapy could be attempted. The pathological report revealed a rhabdomyosarcoma of the gastrocnemius muscle.—*R. M. Harvey.*

VAN CREVELD, S., and SOETERS, J. M. Myositis ossificans progressiva. *Am. J. Dis. Child.*, Nov., 1941, *62*, 1000–1013.

The authors state that in spite of many studies on myositis ossificans progressiva which have been carried out the nature of the disease is still obscure. Their patient was a girl of five years of age. The disease began at about the

age of one and a half years. In some of the reported cases, symptoms were present at birth or appeared in the first few weeks of life. Very rarely did they begin in adult life. No history of rheumatic infection was obtained in their patient, nor was there any note of previous trauma or disease of the central nervous system. The first muscles in which the disease process became manifest were the sternocleidomastoids. The heart, diaphragm, tongue, larynx and sphincters have remained free of involvement. The abdominal muscles were much more affected than in other reported cases and there was an absence of congenital anomalies. The patient did not complain of pain, although in the recorded cases patients in the later stages of the disease often suffered considerable pain. The process may stand still for a considerable time and even distinct regressions have been reported which make it difficult to judge the efficacy of therapy.

In the advanced stage of the disease, the differential diagnosis from calcinosis universalis progressiva must be considered. Both diseases affect primarily the connective tissue. The changes in the muscles in myositis ossificans progressiva are only secondary. In calcinosis universalis progressiva, the hyperplasia of the connective tissue is followed by impregnation with calcium salts. In myositis ossificans progressiva primary calcification never occurs; there is a gradually progressing ossification sometimes with the formation of cartilage as an intermediary step. Roentgenologically, the two diseases are therefore entirely different. In the differential diagnosis the absence of calcification as a primary symptom is the most important argument in favor of the diagnosis of myositis ossificans progressiva next to the presence, in the majority of cases, of congenital anomalies of the fingers and toes. The opinion, now generally accepted, is that in both diseases a primary disturbance is present in combination with a derangement of calcium metabolism, the nature of which is not known. The last mentioned peculiarity leads in some cases to the development of bony masses with real bone structure (myositis ossificans progressiva) and in other cases causes abnormal deposits of calcium salts (calcinosis universalis progressiva).

A number of types of therapy were tried in the authors' patient with unsatisfactory results. However, injections of parathyroid extract were used and after several injections, the calcium content of the serum which had been high, no longer showed any important increase above normal levels.—*R. S. Bromer.*

Carty, John Russell. Some important considerations of soft tissue anatomy as revealed by radiography of anatomical cross-sections. *Radiology*, Dec., 1941, *37*, 726–729.

The anatomy of soft tissues can be studied very effectively by the use of roentgenograms of cross and longitudinal sections through the body. Very fine anatomical detail can be shown if the sections are properly made. This includes the necessity for adequate dehydration and accurate cutting of the sections so that the width is uniform. The technique of preparing the sections developed by H. O. Mahoney of the General Electric X-Ray Corporation is described. The information obtained from these sections is useful not only in the teaching of anatomy but also to the roentgenologist in interpreting soft tissue roentgenograms.—*Audrey G. Morgan.*

ROENTGEN AND RADIUM THERAPY

Schaefer, Walter. Physikalisch-biologische Probleme bei der Bestrahlung der bösartigen Geschwülste. (Physico-biological problems in the irradiation of malignant tumors.) *Strahlentherapie*, 1941, *69*, 167–174.

The author discusses the various problems involved in the transition from the old biological skin erythema dose to the modern dose in roentgens measured physically. He emphasizes the importance of always keeping in view the biological effect of a given radiation dosage regardless of the physical measurement and discusses the new problems introduced by fractionating and prolongation of dosage. He says that he has been performing experiments on rabbits' testicles, which he cannot report in detail until the end of the war, in which he found that a given dose (2,200 r) when fractionated brought about complete destruction of the seminal epithelium but when it was given in a single dose regeneration of the epithelium took place. Too small a biological dose may apparently destroy the tumor but leave certain cells to regenerate, while too large a dose may destroy all of the tumor but injure the surrounding tissues to such an extent that metastasis occurs. The biologist and physicist must work together toward the solution of these problems.—*Audrey G. Morgan.*

MÜLLER, HANS. Zur Allgemeinbehandlung röntgen- und radiumbestrahlter Patienten. (The general treatment of roentgen and radium irradiated patients.) *Strahlentherapie*, 1941, *69*, 175–178.

Roentgen sickness is frequently seen after irradiation; the symptoms are vomiting, nausea, headache and restlessness and diarrhea often accompanied by painful tenesmus and meteorism. This frequently makes patients unwilling to continue treatment.

In the last three years the author has irradiated 398 cancer patients at the Gynecological Clinic of Rostock and has performed 241 roentgen castrations. He has found two drugs that are very effective in treating roentgen sickness. Sympatol is very effective in treating the vegetative nervous system symptoms caused by the body being flooded with the products of cell catabolism. Twenty to 30 drops of the drug are given three times a day and in some cases injections are necessary. Larger doses may be given if necessary. For diarrhea and tenesmus allisatin has proved very effective. Two tablets are given two or three times a day. With these drugs, proper nourishment and plenty of fresh air there is little trouble from roentgen sickness.—*Audrey G. Morgan.*

GRAHAM, ALLEN. Criteria of malignancy. *Radiology*, Nov., 1941, *37*, 521–532.

Clinically it is generally assumed that a tumor is benign as long as it remains localized, does not impair the general health, does not metastasize and does not cause death. If it does grow rapidly, impairs health, invades local or distant tissues or causes death it is considered malignant. From the pathologist's point of view the question of malignancy can only be determined by histological examination and even then frequently only with great difficulty. Sometimes it is impossible to determine by even the most careful examination what was the parent cell of a tumor. The more the cells revert from the adult toward the embryonic type, the greater this difficulty becomes. As a rule, the greater the abnormality in the details of cell structure, the greater the degree of malignancy. On the basis of this fact an attempt has been made to grade tumors histopathologically and determine the degree of malignancy. It is as a rule true also that the greater the departure from the normal type of cell, the more radiosensitive the tumor becomes.

The degree of malignancy must not, however, be confused with the degree of curability. That depends to a great extent on other factors, such as location. If a tumor is not located near a vital organ and is accessible to treatment it may be more curable than one of much less malignancy located in a vital spot. Nor is the amount of destruction a criterion of the degree of malignancy. An aneurysm may destroy vertebrae as readily as a malignant tumor does. The same thing is true of metastases. It is the distribution of metastases rather than the fact of metastasis that influences length of life. For instance, if a cancer of the breast metastasizes to the axillary glands the patient may survive for a long time, but if it metastasizes to the lungs death follows in a short time.

So far as treatment is concerned the tumor must be completely extirpated or destroyed while it remains localized. The prospects for surgical cure depend on the location of the tumor rather than on its degree of malignancy; if it is accessible and removable without injury to vital organs surgery promises success. On the other hand, the success of irradiation depends rather on the degree of malignancy and the consequent degree of radiosensitiveness.—*Audrey G. Morgan.*

JÜNGLING, O., and LANGENDORFF, H. Kann der Mitosenrhythmus Bedeutung gewinnen für die Dosierung bei Krebs? Quantitative Untersuchungen über das Verhalten der Mitosen bei bestrahlten Krebs. (Can the rhythm of mitosis be utilized in dosage for cancer? Quantitative studies of the behavior of mitoses in irradiated cancers.) *Strahlentherapie*, 1941, *69*, 181–230.

Studies of normal tissue have shown that for every tissue there is a daily rhythm of mitosis and that the rhythm of sensitiveness to irradiation runs parallel to this rhythm of mitosis. Small, apparently subthreshold doses cause a hastening of mitosis followed shortly after the irradiation by an increased number of mitoses. All of the animal and plant tissues examined so far show a rapid decrease of mitoses (primary effect) with sufficiently large doses. This progresses until there is an interval free or almost free of mitoses, which increases in length with increasing dosage. This in turn is followed by a renewed increase of mitoses (secondary effect) the extent of which is dependent on dosage and which with moderate doses rises to more than the original mitosis count. This is followed by a wave-like oscillation of the old rhythm, de-

pendent on dosage, leading to recovery of the tissue or to a decrease to zero with cessation of growth.

However, dosage results obtained on one biological object cannot be applied arbitrarily to another. Nor can the rhythms observed on the skin be applied to cancer tissue. The rhythm of the action of irradiation on cancer must be studied on the cancer tissue itself.

Following out this idea the authors have studied 20 human cancers from different parts of the body, applying both single and fractional doses and observing the effects when applied at different periods in the rhythm of mitosis. Curves for a number of cases are given. Analysis of the curves shows that with a dose of 200 to 400 r the mitosis count of the primary effect falls very rapidly within six to nine hours and the height of the secondary effect is reached after twenty-four to thirty-six hours. The rhythm on fractional irradiation was also studied and it was found that with a dose of 450 r every third or fourth day the new irradiation always comes at a time when recovery is in full swing, in which many cells are in the period of premitosis and therefore very sensitive. Also with a fractional dose of 200 r every day the new dose generally falls in the period of secondary effect. With an interval of thirty-six hours the dose will certainly fall at the height of the secondary effect. Of course this rhythm can only be effective as long as the cancer tissue is still capable of a mitosis rhythm. When the period of freedom from mitoses is reached it is no longer effective. In cancer tissue the distance between the threshold injury dose and the lethal dose is much greater than for normal tissue.

As there are still many questions to be answered the authors hope that gynecologists will study their cancer cases from this point of view, investigating the relation of the rhythm of irradiations to that of mitosis.—*Audrey G. Morgan.*

Evans, W. G., and Griffith, H. D. Dosage control of interstitial radium treatments by direct measurement of skin dosage-rate. *Brit. J. Radiol.*, Pt. I, Nov., 1941, *14*, 345–357; Pt. II, Dec., 1941, *14*, 377–385.

The authors describe a method of controlling interstitial treatment of tumors by measuring the actual dosage rate on the skin of the patient. It is used chiefly for cancer of the breast and secondary cancers in the lymph nodes of the neck.

The breast is not a hemisphere as it is ordinarily called, but may be pendulous or even pedunculated. For this treatment it must be brought into a symmetrical position and immobilized during the treatment. A nidrose framework or "crab" is applied over it and through holes in this mould Sievert chambers are admitted. A plan is worked out for each tumor according to which uniform dosage may be given by inserting radon needles in platinum sheaths, one set being introduced transversely into the breast and the other from below upward so as to form a grid lying in a plane tangential to the curve of the chest wall and set correctly in relation to the overlying breast. Diagrams of the proper placing of the needles are given.

In the second part of the paper on the application of this method to secondary carcinoma in the lymph nodes of the neck the same principle is used, the neck being divided into five fields, field 1 covering both submental triangles, field 2 the submaxillary triangle and the upper part of the carotid triangle, and fields 3, 4 and 5 jointly forming an elongated rectangle covering the sternocleidomastoid muscle. Diagrams of the method of inserting the needles are given and for both the primary cancer in the breast and the secondary growth in the lymph nodes tables are given showing the conditions of irradiation and the biological response of the skin in a series of patients. The results show the safety and efficacy of this method of controlling dosage.—*Audrey G. Morgan.*

Sims, George P. High-voltage roentgen irradiation of accessible cancer of skin and mucous membrane. *Radiology*, Dec., 1941, *37*, 666–672.

In the author's past experience with low voltage roentgen treatment of skin and mucous membranes he has had a relatively high percentage of recurrence. He believes this may have been due to the use of massive doses of low voltage radiation with little or no filtration and too small fields.

He has had better results with 200 kilovolts and medium filtration. There have been fewer recurrences, less radiation reaction, more rapid regression of the tumor and primary healing with less scarring. He gives treatments daily or on alternate days with 400 to 600 r measured on the skin with an effective wave length of 0.18 to 0.128 Ångström unit (half-value layer 0.55 to 1.6 mm. copper). Ten to fifteen treatments

are given. The total dosage depends on the response of the tumor. This is a better method of judging than relying on histopathological findings, for sometimes the histopathological picture indicates that a tumor is radiosensitive when clinically it is not. With fractional treatment it is possible to estimate the dosage better and to prevent undesirable reactions.

Theoretically it would be better to vary the voltage, filtration and distance according to the depth of the tumor but as it is impossible to determine this accurately the optimum penetration cannot be predicted in advance. It is better to give too large than too small a depth dose, so as to be sure that all deep cancer cells are destroyed. So far the author has not had any bad effects in the deep tissues. This has been accomplished by limiting the size of the fields by careful screening and by directing the beam at different angles to the surface on different treatment days.

The 200 kv. irradiation with heavier filtration seems to give a more homogeneous and more effective depth dose. There is a greater difference between the lethal dose for tumor tissue and surrounding normal tissue than with low voltage irradiation.—*Audrey G. Morgan.*

Watson, T. A. A simple device for intracavitory "contact" therapy. *Brit. J. Radiol.*, Nov., 1941, *14*, 366–367.

The Chaoul near distance low voltage tube has been used in the treatment of small cancers in body cavities, such as the bladder, mouth, rectum, etc. It is hard to place the tube accurately, however, because of mobility of the parts and movement of the patient. The author describes a device for holding the tube in position. It consists of a metal ring a little larger than the applicator to be used, inside which the applicator can be slipped and held firmly in position. It can be used in the treatment of tumors less than 4 cm. in diameter. Illustrations are given showing its use in tumors of the bladder and tongue and the use of two of the rings on an adjustable frame to outline two opposing fields in the treatment of cancer of the lip.—*Audrey G. Morgan.*

Martius, Heinrich, and Witte, Ernst. Über einige Fortschritte im Bau und in der Anwendung des Körperhöhlenrohres. (Some improvements in the structure and use of the tube for body cavities.) *Strahlentherapie*, 1941, *69*, 29–34.

When it was found that cancer of the uterus could be cured by placing radium or mesothorium preparations in the uterine cavity it was believed that there was a greater difference in the sensitiveness of cancer cells and normal cells to the gamma rays of radium than to roentgen rays. But this has not been proved and it has been shown that roentgen tubes can be introduced into the cavity of the uterus and the same results attained as with radium and much better results than those attained by irradiation of the body surface with large doses.

An improved form of such a tube is described which has a narrow anode neck, only 16 mm. in diameter, for introduction into the cervix. This tube has the advantage over radium that the radiation can be screened off in any desired direction and directed only to the points desired while this is impossible with radium. The tube and the isodose curves produced by it are illustrated. A more detailed description of the tube and its possibilities will be given when more clinical experience with its use has been accumulated.—*Audrey G. Morgan.*

Schönbauer, L. Über das Karzinom der Tonsille. (Cancer of the tonsils.) *Strahlentherapie*, 1941, *69*, 121–126.

The symptoms of early cancer of the tonsil are slight and the author has never seen any cases that came for treatment before the glands were enlarged. Among the 104 cases he had seen at the Radiotherapeutic Institute of the University of Vienna almost all had had the disease from two months to a year.

Surgical treatment of this form of cancer has proved very unsatisfactory. Therefore the author has adopted the plan of using radium treatment alone. He uses needles 23 mm. long filtered with 0.5 mm. platinum, charged with 2 mg. radium element to 20 mm. length. The needles are stuck into the anterior palatine arch in a sagittal direction parallel to each other and about 1 cm. apart. They must be placed so that the large vessels of the neck will not be injured. If the tumor is large it may be necessary to insert needles also into the soft palate, the lateral wall of the pharynx and the base of the tongue. The needles are left in place for 72 to 100 hours, depending on the size of the tumor and the number of needles. The dose per cubic centimeter of treated tissue is about 13 mg-hr. or 1 millicurie-destroyed. About a week after the needles are removed a distant radium treatment is given with an apparatus

charged with 3,000 mg. radium element. The size of the field is 67 sq. cm., the radium skin distance 6 cm. The surface dose is 10,000 to 12,000 r. The dose is given two hours per day up to a total of twenty-four to twenty-eight hours.

Among 52 cases sent in for surgical treatment 26 were inoperable; of the 26 patients operated on only 1 lived longer than five years, or 4 per cent. Among 104 cases sent to the Radiotherapeutic Institute 29 cases were beyond treatment. Radium treatment was given to 75 and 13 of these patients lived more than five years, that is 13 per cent of the total material, or more than three times the percentage of five year survivals under surgical treatment.—*Audrey G. Morgan.*

Lahm, W. Hypophysenbestrahlungen. (Irradiation of the hypophysis). *Strahlentherapie*, 1941, *69*, 304–318.

The author describes 7 cases in which roentgen treatment was used for tumors of the hypophysis, including eosinophile and basophile adenomas, pedunculated tumor of the sella and the so-called chief-cell adenomas. The irradiation seemed to have biological effects in all these cases. They began with moderate dosage (50 to 70 per cent of the skin erythema dose) and persisted for considerable periods. Permanent cure was even brought about in some cases by repetition. The effects consisted in relief of brain pressure symptoms and symptoms due to displacement, decrease of weight, improvement in vision, improvement of metabolism, fall of blood pressure and improvement of the general condition.

A theoretical discussion is given of the possible effect of irradiation of the hypophysis in malignant tumors of the female genitalia. No cases are described which bear directly on this problem. Döderlein suggested this form of treatment in 1923 on the basis of observations which seemed to prove that irradiation of the hypophysis had distance effects on the ovary and on metabolism. That it does have biological effects is proved by the cases described above. It has been shown that irradiated hormones have different effects from non-irradiated ones and that the growth of cancer seems to depend to a certain extent on disturbed fat metabolism. The author believes that irradiation of the hypophysis does have an effect on the growth of the cancer and on the general condition of the woman with cancer, but it is hard to demonstrate objectively just what changes are due to irradiation of the hypophysis. He wishes to call attention to the possibilities of further research along this line.—*Audrey G. Morgan.*

Lederman, M. Mucous and salivary gland tumours; report on a series of 57 cases with special reference to radium treatment. Part I. *Brit. J. Radiol.*, Oct., 1941, *14*, 329–335.

Mucous and salivary gland tumors constitute only about 1 per cent of all tumors. The various theories in regard to their etiology are discussed and 57 cases treated with radium at the Royal Cancer Hospital from 1929 to 1940 inclusive are considered. Of these, 18 were benign and 39 malignant. Forty-four were located in the parotid gland, 6 in the submaxillary gland and 7 outside the glands in the antrum, hard palate, soft palate or anterior naris.

The question of whether biopsy is advisable in these cases is discussed. Recently the authors have adopted the practice of taking biopsies in ulcerated cases or those outside the main salivary glands, giving several days' preliminary irradiation if possible. In non-ulcerated tumors of the main salivary glands biopsy was not undertaken.

Benign tumors of the main salivary glands are well circumscribed mobile tumors that grow slowly. These tumors are particularly likely to recur and the patients should be followed up no matter what kind of treatment is given.

Many authors hold that lymph node and distant metastases are rare in malignant salivary gland tumors. Among the 32 malignant tumors of the main salivary glands in this group 10 (31 per cent) showed clinical lymph node involvement at some stage of the disease. In 3 of the 15 patients who died there was evidence of distant metastasis. Among the 7 cases of extra-salivary gland tumors there was only 1 of lymph node metastasis and none of distant metastasis. —*Audrey G. Morgan.*

Lederman, M. Mucous and salivary gland tumours; report on a series of 57 cases with special reference to radium treatment. *Brit. J. Radiol.*, Nov., 1941, *14*, 368–375.

The author emphasizes the importance of individual consideration of each case and early treatment. The details of the technique in use at the Royal Cancer Hospital, London, over a series of years are given. Conceptions of dosage have changed materially during the past ten years and the doses given during the earlier half

of the period considered seem low considered by present day standards; they varied from 1,500 to 3,500 r.

Teleradium was used as the only method of treatment in 16 of the 57 tumors considered in this article, 12 of them in the parotid gland, 3 in the submaxillary gland and 1 in the hard palate. The tumor dose varied from 3,500 to 7,500 r and the treatment time from nine to forty-two days. Complete resolution of the tumor was brought about in 9 of the parotid tumor cases and in the hard palate case and the minimum period of healing was two years. Among the 3 parotid cases in which healing was not accomplished there was non-cooperation on the part of the patient in 2 and in 1 such a bad general condition that the full course of treatment could not be given.

Details of the other forms of treatment used are given and the results summarized in the form of a table. The author does not attempt to draw statistical conclusions as the number of cases was too small and the details of treatment too varied.—*Audrey G. Morgan.*

HAMMER, GERHARD. Ergebnisse der Röntgenbestrahlung bei Larynx- und Hypopharynxkarzinomen 1933 bis 1939. (Results of roentgen irradiation of carcinomas of the larynx and hypopharynx 1933 to 1939.) *Strahlentherapie*, 1941, *69*, 319–332.

The author reports 15 cases of carcinoma of the larynx and 17 of the hypopharynx treated at Nürnberg from 1933 to 1939. He designates as tumors of the hypopharynx those between the tip of the epiglottis and the base of the cricoid cartilage, which are often included under tumors of the larynx, and this probably is the reason for the difference in his report and that of Meyer on practically the same material.

He gave fractional irradiation, in some cases protracted, with a superficial dosage of 3.3 to 4.0 r per minute. The focal doses were 2,800 to 5,000 r, the individual surface doses 200 to 260 r. Irradiation was given from two lateral fields, in only one case from three fields. One field 6×8 or 8×10 cm. was irradiated each day, only rarely two fields. The time of irradiation varied from seventeen to forty-three days. A study of the results of different techniques does not show much difference in results. Tables are given showing the details of his results.

Among the 10 cases of tumor of the larynx that had not had any previous treatment, he brought about primary disappearance of the tumor in 8, or 80 per cent; after one year 7 of the patients were living, after two years 4, after three years 3, after four years 2, after five years 1 and at the end of the sixth year none. The average survival after the beginning of treatment was 18.4 months.

Among the 17 cases of tumors of the hypopharynx the treatment could not be finished in 3; of the other 14, 7 were dead at the end of one year, all at the end of two years. The average length of life was 11.5 months.

In these tumors very good primary results are possible but there is a high percentage of recurrence and metastases. There may be recurrence after more than four years.—*Audrey G. Morgan.*

DIETERICH, W., and DIETER, W. Erfahrungen mit der Radiumspickmethode. (Experience with the radium implantation method.) *Strahlentherapie*, 1941, *69*, 333–339.

The authors describe the treatment of tumors by the implantation of radium needles at the Municipal Hospital at Mannheim. They use needles charged with 1 mg. radium element filtered with 0.5 mm. platinum-iridium. They are exchanged every five years for freshly charged ones. They found that with the use of more heavily charged needles the reactions in the tissues were too severe. The needles now in use are introduced into the tumor at a distance from 1 to 1.5 cm. from each other and this gives a uniform distribution of the irradiation inside the tumor. The needles must be left in place six to seven days. In some cases in which this could not have been done they have used as high as 4 mg. needles.

The technique of introducing and fastening the needles is described. These needles are used for the treatment of relatively small tumors, such as those of the lower lip, the eyelids, the mouth and nose, the ear, the penis, the vulva, the anus and skin. As a supplement to roentgen or radium treatment they are used in small residual tumors of the vagina, the portio, the breast, large carcinomas of the skin and occasionally of the rectum and prostate, though in the two latter sites they have not as a rule proved successful. A number of illustrative cases are described. Among benign tumors they have used the method in several cases of giant hemangiomas in small children and in keloids, with good results.—*Audrey G. Morgan.*

Barden, Robert Phelps. The influence of roentgen irradiation of normal lung on the prevention of subsequent metastatic tumor growth: preliminary report. *Radiology*, Nov., 1941, *37*, 608–615.

There is still a great deal of controversy in the literature in regard to the question of immunity to cancer. The authors studied the question from the point of view of determining whether the susceptibility of a given organ to metastases from a cancer elsewhere in the body could be modified by roentgen irradiation. Thirty-four rabbits were used as experimental animals. The right lung was irradiated and afterwards tumor material from a Brown-Pearce rabbit carcinoma was inoculated into the testicles. The roentgen technique is described and a table given showing the results. They showed that moderate doses of from 300 to 900 roentgens seemed to decrease the incidence of lung metastases from these inoculated tumors. The best time interval between irradiation and inoculation seemed to be two to four weeks. There was no definite reaction of the cells around the metastatic tumor nodules either in the irradiated or the control cases. A few of the animals developed permanent immunity after the removal or regression of the primary tumor.

Casey reported that when rabbits were inoculated with frozen tumor tissue and later with living tumor the susceptibility of the animals to growth of the tumor was increased. The author's experiments did not confirm this finding.—*Audrey G. Morgan.*

Schmiemann, Rolf. Unsere Behandlung der Genito-Peritoneal-tuberkulose der Frau mit Röntgenstrahlen nach Menge. (Treatment of genitoperitoneal tuberculosis in women with roentgen irradiation by Menge's method.) *Strahlentherapie*, 1941, *69*, 249–262.

Since 1924 the Gynecological Clinic at Würzburg has treated genitoperitoneal tuberculosis in women by the method introduced by Menge, using small, fractional doses lower than the castration dose. They irradiate over a field extending from the symphysis to the umbilicus, giving five irradiations with six week intervals between them; the doses are 120, 100, 80, 60 and 40 surface roentgens. Technique: 180 kv., 4 ma., focus skin distance 50 cm., filter 1 mm. copper and 1 mm. aluminum. If necessary this series of irradiations may be repeated after six months.

Up to December, 1938, they had treated 74 cases. A table is given showing that 61.2 per cent were cured and 22.2 per cent greatly improved; 2.8 per cent were not cured and 13.8 per cent died of the disease. This is much better than statistics collected from the reports of surgical operation. The author believes all cases should be treated by irradiation, as the results are poorer with surgery and sanatorium treatment is much longer and more expensive.—*Audrey G. Morgan.*

Wintz, H. Ergebnisse der Behandlung von Unterleibskrebsen mit Röntgenstrahlen. (Results of treatment of genital cancers with roentgen rays.) *Strahlentherapie*, 1941, *69*, 3–11.

The author has been practicing radiotherapy of gynecological cancer for twenty-five years. His statistics show 55 per cent five year cures in operable cancer of the cervix from 1916 to 1922 and 65 per cent from 1923 to 1934. For inoperable cancer of the cervix the figures are 11 per cent for the first period and 14 per cent for the second. The figures for operable cancer of the body of the uterus are 64 per cent for the first period and 71.5 per cent for the second. For inoperable cancer of the body of the uterus they are 4 per cent and 24 per cent respectively. This great improvement in the figures for inoperable cancer of the body of the uterus is probably due to the fact that in the beginning inadequate doses were used. This was also true of adenocarcinoma of the cervix, which requires a dose of 125 per cent skin erythema dose. As many physicians used too low a dose they reported this group of carcinomas incurable by radiotherapy.

The results for cancer of other parts of the genital tract are not so good because the position of the uterus is particularly favorable for cross-fire irradiation. The four year cures for cancer of the ovary were 37 per cent, the ten year cures 24 per cent.

For operable cancer of the breast, Steinthal Stages I and II, the four year cures were 64.6 per cent, five and six year cures 48.8 per cent, ten year cures 26.6 per cent. For inoperable cases, Steinthal Stage III, the corresponding figures were 22.5 per cent, 13.8 per cent and 7.4 per cent. For recurrences after operation they were 31.3 per cent, 21.8 per cent and 8.3 per

cent. The method in treatment of cancer of the breast is irradiation with 105 per cent skin erythema dose followed by surgical enucleation of the tumor with the electrocautery.

These figures show a higher percentage of cures than after operation. Radiotherapy of cancer of the female genital organs is no longer in the experimental stage but has proved its value. It, too, is a local treatment but with a greater breadth of action than surgery, as it kills cancer cells in the tributary lymph tracts while surgery may disseminate them. As it is a local treatment and recovery after local disappearance of the tumor depends on the general reactive capacity of the body, early diagnosis and treatment is of the greatest importance.—*Audrey G. Morgan.*

MAIER, EMIL. Die Radiumtherapie der malignen Tumoren des weiblichen Genitales. (Radium therapy of malignant tumors of the of the female genitalia.) *Strahlentherapie*, 1941, *69*, 141–166.

The author discusses the methods and dosage of the different standardized radium treatments of malignant tumors of the female genital organs, including near and distant treatment with radium and combined treatments with radium and roentgen rays, radium and surgery and radium electrocoagulation. He further discusses the application of these methods to the different organs of the female genital tract.

The patients treated at the Lainz Municipal Hospital in Vienna are carefully followed up and the results registered. A table is given showing these results for the cases treated from 1931 to 1934. Only cases treated with electrocoagulation and radium needles are given. Thirty-two cases of cancer of the ovary were observed and 12 treated, with five year survival in 2. There were 14 cases of cancer of the body of the uterus, 10 of which were treated, with 4 five year survivals. Of the 22 cases of cancer of the cervix in Stage I, 21 were treated with 13 five year survivals; the absolute and relative five year survivals, that is the percentages of the number observed and of the number treated, were 59 and 62 per cent. In Stage II, 62 cases were seen and 54 treated with 22 five year survivals, or absolute and relative figures of 35 and 40 per cent; for Stage III the figures were 197 cases seen and 175 treated with 33 five year survivals, or 17 and 19 per cent absolute and relative cures. Among the 44 cases in Stage IV, 32 were treated; there were no five year survivals but the patients were relieved of symptoms for periods up to as long as three years in some cases. Of cancer of the vulva 38 cases were seen and 32 treated; five year survivals 10, or 26 and 31 per cent absolute and relative cures. For cancer of the vulva the figures were 38 cases seen and 27 treated with 4 five year survivals or 11 and 15 per cent absolute and relative cures. It is noteworthy that in Stage III of cancer of the cervix which is inoperable, five year survival was attained in 19 per cent of the cases treated. There was a relatively small number of five year survivals in cancer of the vulva. With surgery the primary mortality is very high in this form of cancer and there are many local recurrences. Therefore the five year survival of 15 per cent is comparatively good, especially in view of the fact that these patients were old and in poor physical condition.—*Audrey G. Morgan.*

SAUPE, E. Erfahrungen mit der Thorium-X-Behandlung von Krebsen des Gesichts, insbesondere der Augenlider. (Experience in the thorium X treatment of cancer of the face, particularly of the eyelids.) *Strahlentherapie*, 1941, *69*, 127–140.

The author reports his experience, partly in collaboration with W. L. Meyer, in the treatment of cancer of the face with thorium X needles since 1926 at the Rudolph Hess Hospital in Dresden. The total number of cases was 66, of which 45 were cancers of the eyelids. He refers for details of the technique to the work of Halberstaedter and Simons. Taking three year survival as a criterion, the treatment was successful in 66.6 per cent of the cases of cancer of the eyelids and a failure in 33.4 per cent. But as most of these patients were old or very old this figure gives a mistaken idea of the effectiveness of the treatment. Persons of such advanced age are apt to die within three years of other causes than the cancer. He calculates that the true failures of the method did not amount to more than 20 per cent. Some of these failures occurred in the early use of the method and might perhaps have been avoided later and some of them were doubtless caused, or at least abetted, by carelessness on the part of the patients.

The question of protecting the eyes from the rays is discussed. The use of lid prostheses had bad results in some cases and was given up. Further points discussed are the insertion and

removal of the needles, anesthesia, which is generally unnecessary, the methods used in deep-seated tumors, residual tumors and recurrences, as well as peculiarities in the reaction to the rays and the course of healing.—*Audrey G. Morgan.*

Runge, H., and Vöge, A. Über die Behandlung von Blutungen im Klimakterium unter besonderer Berücksichtigung der intrauterinen Radiumtherapie. (The treatment of hemorrhage in the climacteric with special reference to intrauterine radium therapy.) *Strahlentherapie*, 1941, *69*, 82–94.

The author reviews the treatment of hemorrhage during the climacteric for the past five years at the Heidelberg Clinic and reports that during that time there has been an increasing tendency to replace roentgen treatment by intrauterine radium treatment. Tables and graphs showing the details of the results are given. The histopathological diagnosis of the cause of the hemorrhage is less important in determining treatment than the age of the patient.

Among 701 cases of hemorrhage of the climacteric seen during this period 273 were treated with intrauterine radium and 86 with roentgen rays. The advantages reported for radium are the shorter time required for treatment, the ease with which it is applied, the fact that hemorrhage is stopped immediately and permanently and there is less roentgen sickness and less severe signs of the menopause than with roentgen rays. As it has been found that curettage before treatment is advisable in any case to exclude malignancy, radium may be applied as easily as roentgen rays.

Usually two preparations each containing 25 mg. radium element are inserted with a filtration of 0.6 mm. silver. No further filtration is used as the secondary rays are desirable on account of their effect on the endometrium. Metal rods pass from the preparations through a rubber tube out of the vagina and a loose vaginal tampon is applied. In this way the radium is held in the fundus and yet secretion can be discharged. As a rule, the treatment is borne with only slight symptoms.

The treatment failed to stop hemorrhage in only 6 of these cases, 4 treated with radium and 2 with roentgen rays. In 2 of the cases treated with radium a submucous myoma had been overlooked. The other 2 patients had endometritis and the cavity of the uterus was very large, so that the dose of 2,000 to 2,200 mg-hr. was probably not large enough.

Old inflammatory changes in the adnexa are not a contraindication to radium treatment. In cases with fresh or subacute inflammation radium should not be used. With proper selection of cases there is little danger of ascending infection.

The author has even used radium in 36 cases of hemorrhage before the age of the climacteric when curettage and hormones failed to control the hemorrhage. In 14 per cent of these cases a regular menstrual cycle was re-established and in 48 per cent irregular hemorrhage occurred which was controlled either spontaneously or by the ambulant use of hormone. These patients have been under observation for from six months to five years.—*Audrey G. Morgan.*

Movers, F. Zur Frage der Strahlentherapie bei der Endometriose. (Radiotherapy in endometriosis.) *Strahlentherapie*, 1941, *69*, 281–296.

Endometriosis is supposed to be caused by disturbance of ovarian function and logically therefore it should be cured by roentgen castration. But evidently other factors are involved, for roentgen castration does not always stop the progress of the disease.

The author has previously reported 60 cases of endometriosis treated at the University Gynecological Clinic at Cologne from 1930 to 1940. Since then he has found 4 further cases retreated during this period but not reported. Of these 64 cases 6 were treated with radium or roentgen rays.

These 6 cases are reported in detail. Three of them were cases of retrocervical endometriosis confirmed by histological examination. The other 3 were cases of chocolate or tar cysts of the ovary, not confirmed histologically, but with a very clear clinical picture of endometriosis.

In each of the two groups 1 patient was cured, 1 improved and 1 not improved. The results of radiotherapy are not brilliant and the author thinks operation is to be preferred. If there is recurrence and a second operation has to be performed he recommends total extirpation of the uterus and removal of all functioning ovarian tissue. Radiotherapy alone is to be recommended only in cases in which operation cannot be performed for any reason. If the rec-

tum is involved it is not to be resected. If any ovarian tissue has been left behind and hemorrhage and pain recur irradiation with the carcinoma dose should be given.

As recurrence is frequent in this disease, even after long periods, all patients who have had endometriosis should be kept under observation for at least ten years. Prognosis must be very guarded in all cases in which radical operation has not been performed.—*Audrey G. Morgan.*

GOECKE, H. Über die Ergebnisse der Radium bestrahlung gynäkologischer Blutungen gutartigen Ursprungs. (The results of radium treatment of gynecological hemorrhages of benign origin.) *Strahlentherapie*, 1941, *69*, 263–268.

From January 1, 1925, to December 31, 1939, the University Gynecological Clinic at Münster treated 350 women with benign gynecological hemorrhage by radiotherapy. Of these 171 (48.8 per cent) were treated with radium alone, 157 (44.8 per cent) with roentgen rays alone and 22 (6.4 per cent) were given combined treatment with roentgen rays and radium.

In recent years the use of radium for the treatment of gynecological hemorrhages has been increasing at this clinic because it seems to have certain definite advantages over roentgen treatment. In the first place, it stops the hemorrhage quicker, which is very desirable as these patients are generally anemic. In the second place, the radiation sickness and signs of the menopause are less pronounced after radium than after roentgen irradiation and, in the third place, the cost of a single radium treatment is less than a third that of roentgen treatment.

The uterus is curetted and dried with gauze and the radium inserted at once in a tube with brass walls 1 mm. thick. As a general rule 100 mg. is kept in place for twenty hours making a total dose of 2,000 mg-hr. Generally not more than that should be given but in some cases of severe anemia where it is important to stop the hemorrhage quickly, 3,000 mg-hr. may be given.

Among the 159 cases that could be reexamined later 98.8 per cent were cured. In 1 case the dose of 1,000 mg-hr. given did not stop the hemorrhage permanently and in 2 cases the patients had submucous myomas and the uterus had to be removed as the hemorrhage did not stop after radium treatment. The percentages of cure in the different classes of cases were: preclimacteric hemorrhage 100 per cent, hyperplasia glandularis 94.1 per cent, hypermenorrhea 87.5 per cent, myoma of the uterus 86.6 per cent. There was mild infection after radium treatment in 2 cases, no severe infections and no deaths.—*Audrey G. Morgan.*

SIEGERT, F. Die intrauterine Radiumbestrahlung der Metropathia haemorrhagica und der Uterusmyome. (Treatment of hemorrhagic metropathy and myoma of the uterus with intrauterine radium irradiation.) *Strahlentherapie*, 1941, *69*, 57–81.

Uterine hemorrhage, whether from myoma or from other causes, should not be treated by irradiation during the period of sexual activity. But during the climacteric it has proved of great value because it is more conservative than surgery. The question of whether roentgen or intrauterine radium treatment is to be preferred has now arisen and the author discusses it on the basis of his experience at the Gynecological Clinic of Freiburg.

Roentgen treatment acts primarily on ovarian function while radium acts primarily on the endometrium of the uterus and, because of the rapid decrease of its action with distance, only secondarily and through the hormonal action of the uterus, on the ovary. From a detailed comparison of his results in cases treated with roentgen rays and radium the author concludes that the signs of menopause, particularly the vasomotor disturbances, are milder after radium than after roentgen irradiation and that control of the hemorrhage is brought about more quickly by radium. The immediate control of the hemorrhage and the fact that it does not recur is of special importance in the treatment of hemorrhage from myoma. Radiation therapy should be preceded by curettage in order to exclude malignancy.

In large, multinodular myomas which are not suitable for operation but in which radium alone does not bring about control of the hemorrhage a combined roentgen-radium treatment has proved valuable. These patients, who are very anemic, are first given 1,500 to 2,000 mg-hr. intrauterine radium treatment followed by 35 per cent skin erythema dose roentgen irradiation to each ovary.—*Audrey G. Morgan.*

MAYER, A. Die Entwicklung unserer Therapie beim Uterus-Kollumkarzinom. (The development of our treatment of carcinoma of the

cervix of the uterus.) *Strahlentherapie*, 1941, *69*, 17–28.

The author reviews the work of Döderlein who was one of the most skilled of surgeons in treating cancer of the uterus by the radical Freund-Wertheim operation. But he later became convinced of the greater value of radiotherapy and gave up surgery of this condition entirely for treatment by radiotherapy alone. Mayer succeeded Döderlein as Director of the Tübingen Clinic and gives some statistics in regard to results at that clinic with different types of treatment. From 1902 to 1905 when Döderlein was using surgical treatment alone, the operative mortality was 20 per cent and the percentage of five year cures 16.6 per cent. From 1927 to 1930 when all patients under Mayer were being first irradiated and then treated surgically the primary mortality was 4.5 per cent and the five year cures 23.33 per cent. During 1930 and 1931 when only radiotherapy was being used the primary mortality was 1.5 per cent and the percentage of five year cures 31.6 per cent.

The author still, however, uses surgery in some cases. He performs primary operation in the rare cases of cancer of the cervix in pregnancy and in cancer of the cervix in young patients and secondary operation in cases refractory to irradiation, in cases where no tumor is visible or palpable but a vile-smelling discharge indicates a deep-seated cancer, in cases where stenosis of the vagina has been caused by irradiation and in operable recurrences after irradiation.

Recently he has been opening the abdomen and giving contact irradiation in extremely painful inoperable recurrences. He has had some surprisingly good results with this method.

He also discusses the general treatment of the patients after operation or irradiation and describes a cancer station built in the high mountains for the sunshine and fresh air treatment of such patients. Efforts are also being made to provide adequate care for incurable cancer patients. Some progress has been made in eradicating the intense fear of the very word cancer by constant repetition of the printed statement that cancer is curable.

The question of "mercy killings" in incurable cancer is discussed and rejected for obvious reasons.—*Audrey G. Morgan.*

Eymer, H., and Ries, J. Die Ergebnisse der Strahlenbehandlung der Gebärmutterhalskrebse an der Münchener Universitäts-Frauenklinik im Jahre 1934. (The results of radiotherapy of cancer of the cervix at the Munich University Gynecological Clinic in 1934.) *Strahlentherapie*, 1941, *69*, 12–16.

As the five year period for cases treated in 1934 has now passed, the authors summarize the results of their work for that year, giving a table showing the detailed figures. During that year they observed 213 patients with cancer of the cervix, and treated 206 of them with radiotherapy. The figure for relative cure, that is the proportion of patients well after five years to the whole number observed, was 36.15 per cent, while the absolute cures, that is the proportion of patients well after that period to the number treated, was 37.38 per cent. All the patients observed in Groups I and II were treated; therefore the figures for absolute and relative cure are the same, namely 71.43 per cent for Group I and 52.63 per cent for Group II. This was also true of Stage III, in which the absolute and relative cures were 33.8 per cent. But in Group IV only 62 of the 69 patients observed were treated and therefore the relative figure was 11.6 per cent and the absolute 12.9 per cent.

The number of operable cases 73, was only 34.7 per cent of the total number of cases observed, 213. Therefore the 36.15 per cent of cures by radiotherapy was higher than even the chance for cure by surgery. In the operative group the mortality in radiotherapy was 1 out of 73, or 1.37 per cent, much lower than the surgical mortality in similar groups.

Several changes were made in the treatment during 1934—the preliminary irradiation of the hypophysis was given up and the amount of radium irradiation changed. So statistics for later years will be more uniform. The object of this report is merely to show that radiotherapy alone of cancer of the cervix gives better results than any other method of treatment.—*Audrey G. Morgan.*

v. Mikulicz-Radecki, F. Radiumbehandlung des Kollumkarzinoms während der Schwangerschaft mit dem Ziel eines ausgetragenen, gesunden Kindes. (Radium treatment of cancer of the cervix during pregnancy with the object of securing a normal, full-term child.) *Strahlentherapie*, 1941, *69*, 45–56.

The coexistence of cancer of the cervix and pregnancy is quite rare. At the Königsberg

Clinic from 1930 to 1940, among 992 cases of cancer of the cervix there was pregnancy in only five.

The question of treating these cases is a difficult one. The mother's life must be considered first, of course, and if necessary the uterus and its contents removed. The more conservative roentgen or radium treatment has been tried but Wintz and Wittenbeck in 1933 made a collection of all the cases which had been treated in that way and found that a considerable percentage of the children had been injured by the irradiation. Radium treatment of course is less injurious to the child but a combined radium and roentgen treatment is more effective for the mother. On account of the possible injury to the child Wintz rejects even radium treatment in such cases.

The author, however, in reviewing his cases found that the majority of the cases in which the child had been injured had been treated in the first half of pregnancy while in almost all of the cases treated in the last half of pregnancy the children had been normal. The larger the child, the less danger of injury by the radium.

In 2 of the author's 5 cases radical vaginal operation was performed and the uterus removed. In a third radium treatment was followed by spontaneous delivery. But in the other 2, in which the women were in the eighth and seventh months of pregnancy radium treatment was followed by the delivery of normal children, one of whom has been followed up for two and a half years and the other for two and a quarter years. No abnormalities have developed. In the first case one tube containing 40 mg. radium was placed in the cervix and another containing 25 mg. transversely in front of the portio. The child was in the transverse position so that its head lay at least 12 cm. from the radium. It was calculated that the dose applied to the head was less than $\frac{1}{4}$ skin erythema dose. In the other case the child's head was much nearer the radium, both tubes of which were placed in the vagina. It was calculated that the vault of the skull was given a dose of 5 S.E.D. but the base only about $\frac{1}{8}$ S.E.D. It is possible that roentgen injuries may even yet develop, but hardly probable in the first case. There is a somewhat greater likelihood of late injury in the second case because of the larger dose.

Nevertheless the author thinks it safe to give radium treatment in such cases in the seventh and eighth months of pregnancy.—*Audrey G. Morgan.*

HAUPT, WALTHER. Über die Ansprechbarkeit der Kollumkarzinomkrater auf Strahlenbehandlung. (The response of crater of cancer of the cervix to radiotherapy.) *Strahlentherapie*, 1941, *69*, 35–44.

In a considerable percentage of cases of cancer of the cervix deep craters are formed in the wall. Among 472 cases of cancer of the cervix seen at the Jena clinic from 1936 to 1940 there were 78 with crater, or 16.5 per cent. The greater majority of these cases are inoperable so the only hope of treatment lies in radiotherapy. It is difficult in view of the size of the cavity to keep radium preparations in place. There is danger of their becoming displaced and giving too much irradiation to one side and not enough to the other. There is also danger, in view of the thinness of the wall, of injuring the bladder or rectum.

Notwithstanding these difficulties good results were attained in four-fifths of these cases on treatment with radium or in some cases the use of the intrauterine roentgen tube. A true portio was reformed in only about one-fifth of the cases. It is not necessary to use any larger dosage in these than in other cases. As a rule 30 mg. radium was applied for sixty-six hours and this dose repeated after two to three weeks, making a total dose of about 6,000 mg-hr. The radium should be placed in the uterine cavity, not in the crater itself. It is not advisable to produce an artificial crater by excochleation of a tumor before irradiation. Life can be prolonged for the majority of these patients and complete cure brought about in some cases.—*Audrey G. Morgan.*

WOLFRAM, WERNER. Fünfjahrresultate der Behandlung der Kollumkarzionome in den Jahren 1932 bis 1934. (Five year results of the treatment of carcinoma of the cervix from 1932 to 1934.) *Strahlentherapie*, 1941, *69*, 269–280.

The five year results of treatment of carcinoma of the cervix at the University of Prague from 1932 to 1934 are given in the form of tables and compared with the results published by Friedl for the period from 1929 to 1931.

During the period from 1932 to 1934 the individual operators were allowed to classify the cases and there was an increase of inoperable cases as compared with the earlier period. The increasing use of radiotherapy also probably had something to do with this, for there was a tendency to pronounce cases inoperable and

give them radiotherapy, cases in which operation would have been risked at an earlier period.

Operative treatment consisted of either the Wertheim or the Schauta operation, and all except 8 of the operated patients were also given two series of roentgen treatments of 600 r given four to six times.

Roentgen treatment was given with an old Stabilivolt apparatus. A dose of 600 r was given in about twenty-five minutes over four to seven fields with 180 kv., 4 ma., fields of 150 sq. cm., focus skin distance of 40 cm. and a filter of 0.5 mm. copper and 1 mm. aluminum. If necessary, this was repeated after three to twelve months. If fractionating and protraction were desired the same fields and focus skin distance were used with 1.3 mm. copper and 1 mm. aluminum filtration, 200 to 400 r per treatment until a total of 900 to 1,200 r had been given to each field.

Radium treatment was given with packed radium salt, the dose rarely exceeding 6,000 mg-hr. Half was given at the first treatment and the other half after three weeks. The total filtration was equivalent to 3 mm. lead. The radium was packed in the uterus and in front of the portio in the proportion of 30:60 mg. radium and fixed with a gauze tampon.

There was a tendency also in the later period to make increasing use of Schauta's vaginal operation rather than the more radical Wertheim operation. The mortality was therefore lower—7.4 per cent as compared with 13 per cent.

In the period here reported the absolute five year cure figure was 24.7 per cent, for operable cases 35.13 per cent and for inoperable cases 13.52 per cent. For the 1929 to 1931 period the absolute five year cure figure was 29.14 per cent.

This decrease in cures is probably not attributable entirely to the treatment, but partly to the fact that many patients were lost sight of during the later period because of the extensive migration of the Czech people of the region at that time.—*Audrey G. Morgan.*

Vogt, E. Über die Bildung von gutartigen und bösartigen Tumoren der Gebärmutter und der Eierstöcke nach Röntgenbestrahlung. (The development of benign and malignant tumors of the uterus and ovary after roentgen irradiation.) *Strahlentherapie*, 1941, *69*, 349–355.

Six cases of carcinoma of the uterus, 1 of myoma and 1 of cystoma of the ovary are described which developed in from two to fifteen years after roentgen irradiation for benign hemorrhages or tumors. The author discusses the question of whether previous irradiation creates any special predisposition to the later development of tumors and concludes from his own experience that it does not. But he has the impression that the number of cases of development of tumor after irradiation has increased somewhat in the course of years. He believes that before any roentgen irradiation for hemorrhage or myoma a careful examination should be made under anesthesia, the uterus curetted and a histological examination made of the uterine mucous membrane. If hemorrhage occurs at any period after a roentgen treatment examination should at once be made for malignant tumor.—*Audrey G. Morgan.*

Weisswange, W. M. H. Erhaltung der Ovarialfunktion bei Bestrahlung von Geschwülsten im kleinen Becken. (Preservation of ovarian function in the irradiation of tumors of the pelvis.) *Strahlentherapie*, 1941, *69*, 297–303.

In young women it is important to preserve ovarian function if possible in irradiating for tumors of the pelvis. This can be accomplished in the case of unilateral tumors by irradiating the tumor from several small fields so that a large focal dose will be attained at the tumor and no irradiation will reach the opposite ovary. The irradiated area is kept very small and the source of the rays brought as close to the tumor as possible by compression.

Three cases are described which illustrate this method of treatment. In all 3 cases treatment for a unilateral tumor was given successfully and there has been no recurrence and no interference with ovarian function; 1 patient is well five years after the treatment and the others one year after.

The first patient was a young woman of eighteen who had had a malignant ovarian tumor on the right side removed. Irradiation was given from four fields 10×15 and 8×10 cm. on the upper and lower parts of the right buttock, the right side of the abdomen and the right groin, 200 kv., 6 ma., 0.5 mm. copper and 42 cm. distance. The second patient was a woman of twenty-six with an osteochondroblastoma of the left pubic bone that had recurred after operation, and the third case was particularly interesting as the patient was a girl of fourteen with a sarcoma of the ascending ramus of the pubic bone. Her development was

not interfered with by the treatment. The first patient had some roentgen sickness while the two others did not, probably due to the fact that in the last two cases rays of higher intensity and shorter irradiation times were used.—*Audrey G. Morgan.*

SAUPE, E. Bericht über ein fast 14 Jahre lang beobachtetes, mit Röntgenstrahlen behandeltes gemischtes Beckensarkom, dessen Bestandteile—Rundzellen-,Osteoidsarkom—getrennte Metastasen bildeten. (Report of a mixed sarcoma of the pelvis observed for almost fourteen years and treated with roentgen rays, the constituents of which—round cell and osteoid sarcoma—formed separate metastases.) *Strahlentherapie*, 1941, *69*, 356–364.

A woman aged fifty-one came for examination in the spring of 1925 because of pain in the left hip. Examination showed a sarcoma of the pelvis made up of two distinct parts, one a round cell sarcoma and the other an osteoid sarcoma. The case was followed up for fourteen years until the patient died in 1939 at the age of sixty-five and repeated roentgen treatments were given for the original tumor and the multiple metastases which developed in the course of the years. The two parts of the tumor produced separate metastases. The metastases of the round cell sarcoma were scattered almost all over the body while those of the osteoid sarcoma were limited to the thorax, one particularly betweeen the right pleura and pericardium proving very little amenable to roentgen treatment. A nodule in the right breast proved histologically to be tuberculous.

During this whole period roentgen treatments were given to the primary tumor and numerous metastases that amounted to an astonishing total. A total of 229 treatments was given and a dose of more than 84,000 r. The primary tumor showed a good degree of bone regeneration and a sort of new acetabulum was formed which enabled the patient for a long time to walk and even climb stairs. The only late injury, which was relatively mild, was a chronic indurative edema in the pelvic region.

Naturally the results in this case which proved so effective over so long a period do not constitute a reason for giving such large doses in other cases.—*Audrey G. Morgan.*

HUGGINS, C., SCOTT, W. W., and HODGES, C. V. Studies on prostatic cancer. III. The effects of fever, of desoxycorticosterone and of estrogen on clinical patients with metastatic carcinoma of the prostate. *J. Urol.*, Nov., 1941, *46*, 997–1006.

The activity of carcinoma of the prostate is increased by injection of androgen and decreased by lowering the androgen level. The latter may result from excision of the testes or by estrogen administration. This can be proved by studying the response of the acid phosphatase. The clinical effect of castration in patients with prostatic cancer is shown by increased appetite and weight gain, decreased anemia and pain, decrease in size of primary tumor, regression of bony metastases in the roentgenogram and reduction in size of palpable glands.

In their studies the authors found that 4 out of 12 of their patients with prostatic carcinoma failed to show reduction in the serum acid phosphatase after castration. They assumed that there must be sufficient androgen activity in extragonadal foci to offset the effect of castration. They found that fever decreased the level of both acid and alkaline phosphatase temporarily.

Desoxycorticosterone acetate did not have any effect on the phosphatase level in the patients who failed to show reduction of this enzyme following castration. In 1 of 2 patients estrogen injection resulted in a definite reduction of the enzyme level which had not responded to castration. The mode of action of estrogenic substances in reducing the serum phosphatase level in patients with carcinoma of the prostate is through the following channels: a direct action on prostatic epithelium, inactivation of androgens, depression of the gonadotropic hormones of the anterior pituitary and depression of the interstitial cells of the testis.

The above experimental evidence suggests that means should be employed to eliminate the gonadal androgens in patients suffering from carcinoma of the prostate. This may be done by surgical castration, roentgen irradiation, thermal means and finally if surgical castration is not effective supplementary estrogenic therapy. However, they emphasize that estrogenic therapy is only temporarily inhibitive and not curative.—*R. M. Harvey.*

DEAN, A. L., and SLAUGHTER, D. P. Bladder injury subsequent to irradiation of the uterus. *J. Urol.*, Nov., 1941, *46*, 917–924.

In a series of over 3,000 women receiving irradiation for uterine and ovarian disease 2.48

per cent sought later relief for bladder injury. The percentage was highest after treatment for postoperative recurrent carcinoma of the cervix. Most of the damage results from radium applications. The changes in the bladder occur from one to ten years following treatment. The extent of bladder injury is in general proportional to the amount of irradiation.

Partial devitalization of the cells of the bladder wall occurs with connective tissue replacement in those which do not recover. An obliterative endarteritis occurs in the small nutrient vessels which may result in complete occlusion of their lumens. Trophic ulcers result and occasionally fistulae. The symptoms are sudden in onset and consist of frequency, dysuria, and often hematuria. It is exceedingly important that the correct diagnosis be made. If the changes due to irradiation should be interpreted as malignant and further irradiation administered the results may be disastrous. Gentle cystoscopic examination with biopsy are necessary for a diagnosis. Excretory urograms should be made to complete the examination and should show no involvement of the upper urinary tract.

The authors found that the symptoms usually subsided with clearance of the associated infection. A sulfonamide drug has been used depending on the type of organism found. They present 3 case reports showing the response of irradiation-injured bladders to chemotherapy. The ulcers usually persist after symptoms disappear indicating that the symptoms are due to the associated infection.—*R. M. Harvey.*

Eastland, William E. The role of deep x-ray therapy in pruritus vulvae. *South. M. J.*, March, 1941, *34*, 324–326.

Seven cases of pruritus vulvae have been treated with 200 kv. radiation, using 20 ma., 50 cm. distance, and Thoraeus filter equivalent to 2 mm. of copper. Each case was given 200 r, measured in air, once a week for three to four weeks and then, if necessary, carried to a total of 1,000 or 1,200 r at two week intervals.

These patients had no known organic cause for the pruritus but some, at least, had a neurogenic background. Objective evidence, such as excoriations, fissures, and lichenification, were present, and ordinary measures failed to give satisfactory results.

Six of the 7 treated cases were reported as well or with inconsequential symptoms. One patient was only temporarily improved.—*G. W. Chamberlin.*

Weiss, Konrad. Zue Frage der Hyperpigmentation des Haares nach temporärer Epilation. (Hyperpigmentation of the hair after temporary epilation.) *Strahlentherapie*, 1941, *69*, 340–348.

A case is described in which a man of eighty-four was irradiated for a tumor of the left parietal and occipital region which was apparently a round cell sarcoma of the Ewing type; the histological examination was not absolutely conclusive as only a small amount of material was obtained by puncture. From January 22 to 28 he was given 1,100 r with a filtration of 0.5 mm. zinc and 1 mm. aluminum. A month later he was given the same irradiation and in September of the same year 600 r. When he appeared for the third irradiation the tumor had almost entirely disappeared and the irradiated area was surrounded by a border about 1 cm. broad of black hair, somewhat coarser than the hair of the rest of the scalp. Two and a half years after the beginning of the roentgen treatment the patient showed no tumor and no symptoms, and the pigmentation of the hair was slowly decreasing in intensity.

The author denies Ullmann's theory that such pigmentation of hair after epilation is a rejuvenation of the tissues caused by the irradiation. He thinks it may be due to the fact that the destruction of cells by the irradiation furnishes material for pigment formation and that the ferments necessary for the production of pigment may also be increased by the irradiation. In this connection, he reports the case of a roentgenologist who had had gray hair and beard but after a long period of working almost daily exposed to rays his hair and beard turned black.

He urges the reporting of all cases that bear on the question of biological effects of irradiation, as such effects on human beings are much more significant than the results of animal experiment.—*Audrey G. Morgan.*

MISCELLANEOUS

Jones, Clifford. A portable dark room for processing x-ray films rapidly. *Radiology*, Dec., 1941, *37*, 740–742.

An apparatus for taking and developing roentgenograms in the operating room during operation is described and illustrated. It con-

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He urges the reporting of all cases that bear on the question of biological effects of irradiation, as such effects on human beings are much more significant than the results of animal experiment.—*Audrey G. Morgan.*

MISCELLANEOUS

Jones, Clifford. A portable dark room for processing x-ray films rapidly. *Radiology*, Dec., 1941, *37*, 740–742.

An apparatus for taking and developing roentgenograms in the operating room during operation is described and illustrated. It con-

sists of a light-proof box enclosing a safe-light and tanks for processing solutions so arranged that the film can be watched during its development by the use of a periscope and mirror which reflects rays transmitted through the film from the safe-light. Two solutions of regular commercial developer and fixer are used. The films developed in this way are not perfectly processed but they are good enough to give the surgeon the information he needs. They can be inspected by the surgeon in the operating room two minutes after exposure.—*Audrey G. Morgan.*

SANDERSON, STEVENS S. A simplified method of preserving radiographs and allied records on miniature films. *Radiology*, Nov., 1941, *37*, 616–621.

Excellent reproductions of roentgenograms can be made on 35 mm. films. It is needless to emphasize the importance of being able to keep permanent records of roentgenograms for future study and to keep them in a very small space. The author describes and illustrates a simple apparatus for this purpose and explains how it is used.—*Audrey G. Morgan.*

SUTHERLAND, CHARLES G. The reproduction of roentgenograms on films of millimetric dimensions and suggested potentials of utility in this procedure. *Radiology*, Nov., 1941, *37*, 622–627.

The author, who is Librarian of the Radiological Society of North America, discusses the reproduction of roentgenograms on millimetric films. This makes it possible to store enormous numbers of these reduced roentgenograms in a very small space. Valuable work has been done in producing a microfilm reader for the enlargement and reading of these miniature films. The microfilm reader is still being studied with a view to improvement. The unit is described and the suggestion made that a National Roentgenological Film Library be established with branch reference libraries. This would enormously increase the possibilities of teaching in roentgenology. Another possibility would be the re-establishment of the roentgenologic libraries of foreign countries after the war. This is a preliminary report made with the purpose of stimulating further work on the subject.—*Audrey G. Morgan.*

CURTISS, L. F. Protective screening of radium during transportation. *Radiology*, Nov., 1941, *37*, 628–630.

There is little danger of injury to postal or express employes in the handling of packages of radium for shipment, for each person is exposed to it for so short a time. But in 1937 a report was made to the postoffice authorities that a shipment of photographic film had been injured by coming into contact with a radium shipment. After investigation radioactive materials were excluded from the mails. The Bureau of Standards was asked to work out conditions under which radium could be shipped without danger to photographic film shipped with it. So far it has not been possible to find the necessary segregation of radium under the conditions of postal shipments for the low cost of parcel post shipments is due to the fact that they can be packed in a small space and radium would have to be packed close enough to other materials so that it might damage them. The necessary distance for safety is 20 feet. So the shipment of radium by mail is still forbidden.

But the Express companies have more latitude with regard to distance between packages. But in order to ship by express each package containing radium must be clearly labeled, the amount of radium contained in it must appear on the outside and the thickness of the lead screening used must be indicated. A table is given showing the thickness of lead screening necessary and the allowable hours in transit for various quantities of radium. The concentric lead shells used as screens are illustrated and the method of packing them and labelling the package.—*Audrey G. Morgan.*